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[FOURTH SERIES.]

ART. XIX.—*Some Peculiarities of Rock-Weathering and Soil Formation in the Arid and Humid Regions;* by E. W. HILGARD.*

SOME of the differences in the processes and the results of weathering in the arid and humid regions respectively have been long commented upon; but we do not find anywhere a measurably full discussion of the subject. I have discussed the various phases as observed by myself, in various publications; but I desire to give in this place a summary of the points noted, especially as regards soil-formation, and the conclusions to be drawn therefrom.

The potent effects of water upon both the mechanical and chemical processes of rock decomposition being well understood, the relative scantiness of rainfall in the arid regions leads us at once to expect a slower rate of decomposition of rocks and of their component minerals under the arid régime. The old observation of the freshness of the surfaces of half-finished obelisks in the quarries of Syene, and the good conservation of the same in the obelisks of Lower Egypt under slightly more humid conditions, as compared with the fate of Cleopatra's Needle at New York, are familiar to all. It is not, of course, moisture alone, but very essentially the temperature conditions accompanying both its abundance and scarcity, that are concerned in the effects produced.

Aridity being intimately correlated with the existence of deserts, we are at once led to associate sand and dust with arid conditions. The dust storms of the arid regions are as proverbial as are the sands of the desert; and the latter are in the public mind the symbol of sterility. It is only of late that

* Read at the December meeting of the Cordilleran Section of the American Geological Society, at Berkeley, Cal.

the almost invariable high productiveness of the desert sands under irrigation is becoming a somewhat familiar conception, yet accepted with difficulty because in the more familiar humid region, "poor sandy lands" are a well-authenticated fact, and a "strong" or "substantial" soil is one containing a more or less considerable proportion of clay.

The reasonableness of this popular idea is well illustrated in the investigation made years ago by Dr. R. H. Loughridge,* of a very generalized loam soil covering the uplands of Kentucky, of Tennessee, Mississippi, and Louisiana east of the Mississippi river. In this investigation it was shown that by far the greater portion of the recognized plant-food ingredients was contained within the impalpable portion, viz., the "clay" and finest silts, only an insignificant amount being found in the "sandy" portion of the soil. The extreme poverty of the sandy lands of Florida, as shown by analyses subsequently made by him, fully corroborated these points for the humid region of the cotton states at least. And in Europe, the sandy lands of the northern plain are equally sterile without fertilization.

How is it then that the sands and dust of the arid region are so highly productive so soon as irrigated?

A comparative microscopic examination of sands from Florida and that from the arid deserts at once reveals the difference, which is equally accentuated by their chemical analysis. While the Florida or Mississippi soil sand under the microscope shows almost wholly quartz grains with clean, polished surfaces, the typical desert sand shows a great variety of minerals in granular form, coated with half-decomposed, finely pulverulent mineral matter, which also constitutes the "dust" portion of the material. Analyses made of the coarse and fine portions of such soils by Mr. L. M. Tolman † and by E. C. Lea (unpublished), proved that the surface-covering of the coarse sand grains was practically of the same composition as the fine dust itself. The subjoined table shows that in the typical upland clay loam from Mississippi (a soil noted for its high product of cotton) dissolution of soil ingredients substantially ceased when a diameter of only ·036^{mm} of the soil granules was reached; while from that limit, in the coarser portions of the California soils, obtained by the same process of hydraulic eleutriation, and up to half a millimeter diameter, there was not only no diminution but an actual increase of acid-soluble matters.

It thus appears that while in the humid Mississippi soil, solubility of plant food practically ceased above a grain-diameter

* This Journal, Jan. 1874.

† Rep. Calif. Exper. Station for 1898–1901, p. 33.

of ·036mm, in the arid California soils as large an amount was found in the sand-grain sizes between ·12 and ·50mm as in the ·016 to ·025mm silt of Mississippi.

How does this radical difference between the sands of the arid and humid regions come about? The pulverulent nature of the soils formed under arid conditions supplies the answer. The binding material, the "clay," that forms so important a character of the prevalently clayey and loamy soils of the humid region, is in the properly arid soils present in minute proportions only; except of course where clays from prexisting clay formations have taken part in soil formation, or where,

Sediments.	Per cent in Soil.	Potash.	Lime.	Magnesia.	Phosphoric Acid.	Soluble Silica.	Alumina.	Total soluble.
Colloidal clay, ? diameter.								
Mississippi	21·64	·32	·03	·29	·04	7·17	3·97	11·82
California (Chino)	7·60	·16	·14	·17	·04	1·70	1·35	3·56
California (Jackson)	16·43	·13	·12	·08	·05	2·83	2·13	5·34
Very fine silt, ·016mm diam.								
Mississippi	35·10	·41	·15	·36	·07	2·87	1·36	5·22
California (Chino)	18·53	·24	·53	·29	·06	4·96	1·76	7·84
California (Jackson)	34·90	·10	·04	·08	·02	2·50	2·44	5·18
Fine silt, ·016–·025mm diam.								
Mississippi	13·67	·12	·09	·10	·02	·32	·17	·82
California (Chino)	5·49	·05	·11	·02	·01	·80	·51	1·50
California (Jackson)	9·96	·08	·04	·10	·01	1·01	1·01	2·25
Silt, ·025–·036mm diam.								
Mississippi	---	--	--	--	·36	--	--	·36
California (Chino)	3·92	--	--	--	--	--	--	lost
California (Jackson)	7·68	·06	·02	·05	·01	·82	·74	1·70
Silt, ·036–·047mm diam.								
California (Chino)	6·40	·05	·18	·07	·01	·80	·55	1·66
California (Jackson)	8·21	·04	·01	·003	·001	·43	·64	1·22
Coarse silt, ·047–072mm diam.								
California (Chino)	7·92	·06	·20	·03	·02	·89	·59	1·79
California (Jackson)	5·91	·03	·01	·01	·003	·42	·30	·77
Fine sand, ·072–·120mm diam.								
California (Chino)	11·87	·06	·26	·10	·03	·98	--	1·43+
California (Jackson)	4·03	·01	·01	·005	·003	·28	·09	·408
Coarser sand, ·120–·050mm diam.								
California (Chino)	36·11	·11	·69	·12	·04	2·43	1·59	4·98,
California (Jackson)	10·10	--	--	--	--	--	--	not detd.

as in swamps or marshes, humid conditions exist in the arid region as well.

Since kaolinization, which must precede the formation of colloidal, plastic clay material, is essentially a process of hydration, the presumption is that it will progress more slowly in regions of deficient rainfall. That this is actually the case can hardly be questioned by any one who has studied comparatively the results of rock decay in both the arid and humid regions; the contrary assertion, lately made, cannot, so far as I know, be supported by any facts properly observed and interpreted. The contrasts between the condition of the granites and granodiorites on the upper portions and the lower slopes of the Sierra Nevada and of the Sierra Madre of southern California, and still more between the latter and the southern Alleghenies, are so strongly accentuated as hardly to require discussion. The enormous deposits of almost fresh granitic sand at the base of the southern arid ranges, so coarse that the trees and seeds must be planted far below the surface in order to maintain life, while in the Alleghenies a clay subsoil formed in place lies within a foot of the surface on which the planting is done, are a practical demonstration of the greater intensity of clay-formation in the humid regions.

These differences in characters of the regolith of the two regions may be schematically illustrated in a diagram. This would show that in the humid region the humous "soil" as a rule extends only from six to nine inches from the surface, these being the depths prescribed by the Eastern Experiment stations for the taking of samples of "surface soil"; beneath which follows almost invariably a more clayey subsoil, which as a rule is unadapted to the growth of crops, so that not more than half an inch of it is allowed to be plowed up to the surface at once, on pain of spoiling the seed-bed for the succeeding season at least. No such restriction applies to the typical arid soils, in which the "surface" or humous soil is rarely less than three feet in thickness, and frequently extends to a much greater depth even with a considerable humus-content. This state of things is illustrated by the columns of California soils, in two of which the humus has been determined as reaching to the depth of twelve feet, as shown in the table here presented; and doubtless to at least one foot beyond.

The root of a hop plant here before you illustrates one of the practically most important results of this great depth and pulverulent texture of soils in the arid region. This root at ten feet is still over a millimeter in diameter, and of course went at least two feet deeper than the specimen shows. Now

since a root cannot perform its functions in the absence of the oxygen of the air, it is clear that the air readily penetrates to the depth shown; and in many cases observed, even to as much as twenty feet and more. And since both air, moisture and humus are found at these depths, this implies not only that the farmer in the arid region can fearlessly plow to any practicable depth, but also that the mass of his available soil is from three to five times as great as that of an equal area of land in the humid East. In other words, he has several farms one above another, instead of a single one with one or two feet of available soil and subsoil.

If this be so, then it might be allowable in the arid region to use the regolith materials thrown up from cellars directly as cultivable soils. Daily experience shows this to be the case. Except where heavy clay soils prevail, or where wet maceration has at some time consolidated the subsoil mass, the materials from eight or ten feet depth dug out of cellars or the foundations of houses can oftentimes be directly used as surface soils in garden and fields; and the farmer in grading his land for irrigation ordinarily excavates it as deeply as may be necessary without fear of the "raw subsoil," as would be needful in the humid East. The prompt natural afforesting of the placer and even hydraulic mines in California teaches the same lesson.

Searching for the physical and chemical causes of this state of things, we see at once that it is mainly referrible to the pervious, pulverulent nature of the regolith, which is itself the result of the absence or great deficiency of plastic clay. It is immaterial whether or not this is concurrent with a slow rate of kaolinization, as the microscope seems to indicate. It is quite certain that the *plastic* clay substance, the "colloidal clay," is formed only in small amounts; and this is quite consonant with what we know of the transformation of kaolin into plastic clay. Mere pulverization will not accomplish this; under wet trituration* it is certainly at least a physical hydration process, which does not occur in the case of other fine powders. It is true that the latter may be molded into shape when wetted; but that shape is not retained after drying if any pressure is applied, while clay proper dries into a hard, resistant mass, such as in arid climates like that of Mesopotamia has not even required burning to retain the Assyrian inscriptions for thousands of years. These ancient nations understood the peculiar character of plastic clay better than those who to-day contend that its plasticity is simply due to the fineness of its particles; for we nowhere find that chalk or

*See Johnson and Blake, this Journal, May, 1867.

other easily obtainable fine powders have been similarly used. Nor will the finest "slickens" of our quartz mills, which remains suspended indefinitely in distilled water, serve for modeling, any more than for pottery or porcelain. The utmost possible comminution of graphite or talc, so closely similar to kaolinite in softness and crystalline texture, will fail to impart to them anything resembling the adhesive plasticity of colloidal clay.

In the humid region the abundant and long-continued rains cause the plastic clay in the surface soil to diffuse in the soil water and to be carried into the subsoil, where much of it stops at a shallow depth and thus produces the clayey subsoils of humid regions. In the arid region, notwithstanding the extreme fineness of many soils which causes them to rise as dust at the slightest breath of wind, no such action occurs and thus opportunity is afforded for the deep penetration of roots, which allows much of the ordinary vegetation brought from the humid region to do without rain or irrigation during a six months drought.

The fact that in most parts of the arid regions, the scanty rains occur during the coldest portion of the year, probably accounts in a large measure for the retardation of rock decay; which, others things being equal, is probably in all cases accelerated by heat. On the other hand, the abrupt and constantly recurring changes of temperature account for a large part of the physical disintegration which produces the great masses of pulverized rock or sand which we find in "desert" regions. The intense radiation of heat into space through the far undersaturated air of the arid climates, which occurs so soon as the sun disappears and often results in the violent disruption of cobbles from unequal contraction, naturally affects profoundly the macrocrystalline rocks especially; crumbling their surface and enabling the torrents to carry off almost fresh "sand" composed of all the mineral rock-constituents into the arid valleys; where under the influence of vegetation and increased moisture their chemical decomposition can progress more rapidly.

Not, however, rapidly as in the humid region, where the humus acids aid materially in mineral decomposition. For not only is the humus-content of arid soils usually very much less than in the humid, but so soon as formed such acids are neutralized by the carbonate of lime always present in far greater proportion than in the humid soils, save when the latter are directly derived from calcareous formations. This leads us to the consideration of chemical peculiarities of arid and humid soils respectively.

*Average Composition of Soils in the Humid and Arid Regions of the United States.**

	Humid.	Arid.
No. analyzed.	696	573
Insoluble residue	84·17	69·16
Soluble silica	4·04	6·71
Sum of insoluble residue and soluble silica	87·68	75·87
Potash	·21	·67
Soda	·14	·35
Lime	·19	1·43
Magnesia	·29	1·27
Br. ox. of manganese	·13	·11
Peroxide of iron	3·88	5·48
Alumina	3·66	7·21
Phosphoric acid	·12	·16
Sulphuric acid	·05	·06
Water and organic matter	4·40	5·15
Hygroscopic moisture	--	5·46
Humus	1·22	1·12
Nitrogen in humus	5·00	15·23
Nitrogen in soil	0·17	0·14

The table before you shows these peculiarities, which I have somewhat elaborately discussed elsewhere. A glance shows the main points of difference to lie just where they would be expected as resulting from a diminished rainfall, causing a corresponding diminution of the leaching-out process, which in the humid climates is the necessary consequence not only of a large rainfall, but especially of its occurrence during the warm season, when the concurrent effects of warmth and the consequent evolution of carbonic acid, both from the roots of vegetation, and from the oxidation or fermentation of dead vegetable matter, can be exerted. Hence we see that the lime which in the humid region is constantly and abundantly leached out into the drainage and streams, is in the arid retained to an extent amounting to from ten to thirteen times the average content found in humid soils not directly derived from calcareous formations. A similar condition is found as regards magnesia, through to a less degree. Potash averages the triple amount. It may seem strange that a similar relation is not shown here as regards soda; the reason is that for fairness of comparison, alkali soils are not included in the list. It is well known that in the case of zeolitic silicates, such as are known to exist in soils, potash is retained more tenaciously than soda. The latter is therefore washed down to the lower ground, and there gives

* Soils directly derived from calcareous formations have, equally in both regions, been excluded from this comparison.

rise to "alkali soils," which characterize the arid region to a greater or less extent all over the world. Their chief soluble salts are usually the *chloride*, *sulphate* and *carbonate* of sodium, varying in relative proportion from place to place at short distances. These differences are largely due to cross-reactions between the salts of the alkalies and alkaline earths under the influence of carbonic acid formed within the soil by the usual processes, resulting, e. g., in the formation of sodic carbonate and calcic sulphate from sodic sulphate and calcic carbonate. Magnesic sulphate is similarly formed. But on exposure of the soil to free diffusion of air, the process may go backward so far as to re-form the original compounds.

The peculiar effects of sodic carbonate upon clay, causing it to diffuse from the flocculent condition into single-grain structure, frequently results in the formation of "alkali hardpan" at the depth to which the annual rainfall usually reaches. This characteristic of "black alkali lands" is illustrated in the diagram before you, showing that at the depth of three feet there is a maximum of accumulation of carbonate, cementing the soil into a hard, tough mass which is quite inaccessible to ordinary means of disintegration, and yields reluctantly even to dynamite; but is quickly and completely resolved into a pile of crumbs when subjected to the chemical action of gypsum and water. This affords a ready means of reclaiming "black alkali" lands, so far as the present price of land plaster will permit; since the sodic sulphate thus formed is at least four times less injurious to vegetation than the carbonate.

Unfortunately there is no practically available chemical reaction by which the highly injurious common salt could be changed into sulphate. The same is true of the calcic and magnesic chlorids, which are occasionally, though fortunately not very frequently, found in the soluble salts of alkali lands.

The difficult solubility of calcic phosphate explains why the leaching process which causes such large differences in the other important plant-food ingredients, is not apparent in the average phosphoric acid-content of the two regions.

It goes without saying that so far as plant-food ingredients are concerned, alkali lands are from their very origin very rich in them, and when reclaimed by leaching or otherwise are profusely and lastingly productive. Aside from a high "reserve," they always contain *water-soluble* potash, and very commonly nitrates and phosphates also.

What action these salts exercise in the weathering process is not well established except as regards the sodic carbonate, which undoubtedly is active both in dissolving free silica and in decomposing silicates.* That common salt in presence of

*On the Geologic Efficacy of Alkali Carbonates. This Journal, August, 1897.

the humus acids of the soil might exert "aufschliessende" action also, seems at least probable from its effect in "rusting" metals, and from that of lactic acid in the animal stomach. The sulphate is probably very inert in this respect.

An interesting and important difference exists in the nitrogen-content of the arid and humid soils, respectively. The average humus-content of the properly arid soils is materially less than that of the humid, as might be expected from the much smaller amount of vegetable debris that finds its way into the soil. As a matter of fact, the leaves of all the spring vegetation of the arid region remain outside of the soil and are oxidized away during the hot summers, leaving little more than their ash behind. It follows that the humus of the arid soils is almost wholly derived from the decay of roots alone; and the deep penetration of the latter, already referred to, explains the occurrence of humus down to the great depths shown in the small table below, which gives the humus percentages found in a bench soil in which hop roots penetrated over twelve feet.

Humus in Russian River bench soil, from one to twelve feet depth.

Depth, feet	1	2	3	4	5	6	7	8	9	10	11	12
Humus %,	1·21	1·16	1·14	1·17	·74	·60	·47	·78	·54	·52	·53	·44

But the total humus percentage in arid soils is usually so small that in the humid region it would be considered wholly inadequate. So it would be, from two causes: first, that it is there among the first things needful for the maintenance of proper tilth in the clayey lands, while in the pulverulent soils of the arid region this is much less necessary; second, because we find the nitrogen-content of arid humus to be on the average three or more times higher than is the case in the humid. Hence the adequacy of the minute amounts of humus found in many of the most esteemed arid soils (·25 per cent and even less); to which may be added the at least probable greater intensity of nitrification when no great excess of carbon and hydrogen compounds is present to compete with the activity of the nitrifying organisms; an activity which, moreover, can evidently progress at much greater depths in the pulverulent, pervious arid soils.

The physical and chemical details of this subject are quite complex, so that a full discussion is necessarily lengthy. But the summary here given is probably enough to show its wide theoretical as well as practical interest, and the need of caution in applying the maxims of the humid region in arid climates.

Art. XX.—*The Colorimetric Determination of Small Amounts of Gold;* by Ralph Nelson Maxson.

[Contributions from the Kent Chemical Laboratory of Yale Univ.—cxlv.]

Application of the colorimetric method for the estimation of small amounts of gold, based upon the purple of Cassius coloration, have been proposed by Carnot,* Rose,† Sonstadt,‡ Cassel,§ Prister,‖ Moir¶ and others, but the use of this reaction for such a purpose is open to objection. According to the authority of other workers, the coloration thus produced is extremely variable, varying in intensity and shade according to the condition of the solution and precipitant. Moreover the substance is unstable, and artificial standard solutions are necessary if accurate results are to be obtained.

It has been suggested that the coloration of red colloidal gold suspensions might have a quantitative relation to the amount of metal present and a method of colorimetric estimation, free from the objections stated above, be based upon this relation. The following investigation was therefore undertaken in the hope of discovering whether such a relationship would not offer a suitable means for the estimation of small amounts of gold.

The preparation of the red colloidal suspensions was naturally the first object of interest. Blake** has shown that acetylene is the most suitable reagent for effecting the reduction of the auric salt, the treatment consisting in drying the chloride at 170°, dissolving in ether, and pouring the etheral solution into water also containing ether and saturated with acetylene gas. The use of ether was objectionable for the purpose of this investigation and the simpler procedure described below gave good results.

The measured quantity of a standard solution of the auric salt was drawn off into a calibrated flask and treated with a suitable amount of an aqueous solution of acetylene, made by dissolving the previously washed gas in water distilled and cooled in tin. The color having developed, the solution was shaken and the flask filled to the mark. The gold solutions used in these experiments were prepared from pure gold chloride, which contained hydrogen chloride in the usual amounts, and had not been subjected to a preliminary drying. The standard of these solutions was determined gravimetrically by means of magnesium ribbon, and by the electrolytic process with the

* Compt. Rend., xcvii, 105 and 169. † Chem. News, lxvi, 271.
‡ Chem. News, xxvi, 159. § Eng. and Min. Jour., 76, xviii, 661.
‖ Jour. Chem. Met. and Min. Soc. of South Africa, iv, 235, 1903.
¶ Jour. Chem. Met. and Min. of South Africa, Sept. 1903.
** This Journal, xvi, 381 (1903).

revolving cathode. Solutions of less concentration were then obtained by suitable and accurate dilution.

A preliminary series of qualitative and quantitative experiments gave evidence that the coloration was of a quantitative nature and that the suspensions were sufficiently stable under suitable conditions.

The Gallenkamp colorimeter was used in the subsequent quantitative experiments immediately following. The delicacy of the readings was increased by placing the instrument in a light-tight box pierced with suitably situated holes; the influence of external colors was avoided by admitting light to the instrument from a ground glass plate, which was found to be very efficient.

It is a well known fact that small amounts of electrolyte will rapidly change "red" gold to the "blue" modification. It is necessary therefore to conduct the comparisons in a room reasonably free from fumes, and to have all containing vessels free from soluble material. It was found that flasks which had been treated with steam for a few minutes gave the best results. Red suspensions contained in such flasks gave no trace of blue after an interval of several weeks.

Using the precautions outlined above, the results shown in the following table were obtained. The error of the personal equation was determined by means of a series of comparisons conducted with different concentrations of the same suspension, and covering a range of amounts of material identical with the amounts handled in the experiments given below.

The forty-nine analyses given in the table were made under widely varying conditions. The age of the suspensions varied from a few minutes to several weeks. In order to avoid error of measurement, new standard suspensions were prepared from time to time, and their concentrations are shown in the last column of the table.

The analyses covered a wide range in amounts of gold and were conducted under varying conditions of light. The results are seen to run with fair regularity and the errors are approximately of the same order of magnitude.

The Gallenkamp colorimeter, used in the foregoing experiments, is not only expensive but cumbersome and complicated in construction; moreover, the instrument is not suitable for the correct estimation of the most minute amounts of gold, the color becoming too faint for accurate comparison because of the shortness of the columns of liquid. A modified form of the type of apparatus proposed by Penfield for the colorimetric estimation of titanium and consisting of comparison tubes set vertically in a dark box and illuminated from below, was therefore adopted. The tubes used in these comparisons had a

TABLE I.

No.	Strength of solution. per cent.	Gold taken. grm.	Gold found. grm.	Error. grm.	Gold in 1^{cm3} of standard. grm.
1	99·6	0·00080	0·00086	+0·00006	0·000086
2	95·5	0·00077	0·00082	+0·00005	
3	90·9	0·00075	0·00078	+0·00003	
4	85·7	0·00073	0·00074	+0·00001	
5	84·3	0·00071	0·00073	+0·00002	
6	67·6	0·00062	0·00058	−0·00004	0·000086
7	63·4	0·00058	0·00055	−0·00003	
8	56·0	0·00054	0·00048	−0·00006	
9	52·0	0·00052	0·00045	−0·00007	
10	47·9	0·00047	0·00041	−0·00006	
11	98·6	0·00081	0·00085	+0·00004	
12	88·2	0·00075	0·00076	+0·00001	
13	78·8	0·00070	0·00068	−0·00002	
14	71·6	0·00065	0·00062	−0·00003	
15	66·1	0·00059	0·00057	−0·00002	
16	60·4	0·00054	0·00052	−0·00002	
17	57·8	0·00048	0·00050	+0·00002	
18	49·8	0·00043	0·00043	±0·00000	
19	44·1	0·00038	0·00038	±0·00000	
20	36·4	0·00032	0·00031	−0·00001	
21	98·6	0·00081	0·00085	+0 00004	0·000086
22	88·2	0·00075	0·00076	±0·00001	
23	78·8	0·00070	0·00068	−0·00002	
24	71·6	0·00065	0·00062	−0·00003	
25	66·1	0·00059	0·00057	−0·00002	
26	60·4	0·00054	0·00052	−0·00002	
27	57·8	0·00048	0·00050	+0·00002	
28	49·8	0·00043	0·00043	±0·00000	
29	44·1	0·00038	0·00038	±0·00000	
30	36·4	0·00032	0·00031	−0·00001	
31	87·8	0·00030	0·00030	±0·00000	0·000034
32	79·1	0·00028	0·00027	−0·00001	
33	71·7	0·00026	0·00024	−0·00002	
34	63·1	0·00024	0·00022	−0·00002	
35	57·6	0·00022	0·00020	−0·00002	
36	46·6	0·00019	0·00016	−0·00003	0·000034
37	44·6	0·00017	0·00015	−0·00002	
38	35·8	0·00015	0·00012	−0·00003	
39	28·9	0·00013	0·00010	−0·00003	
40	16·4	0·00004	0·00006	+0·00002	0·000034
41	21·9	0·00007	0·00007	±0 00000	
42	25·9	0·00009	0·00009	±0·00000	
43	36·9	0·00011	0·00013	+0·00002	
44	46·5	0·00013	0·00016	+0·00003	
45	38·3	0·00015	0·00013	−0·00002	
46	47·3	0·00017	0·00016	−0·00001	
47	Lost by accident				
48	56·8	0·00022	0·00019	−0·00003	
49	66·1	0·00024	0·00023	−0·00001	

diameter of 1^{cm} and a length of 13^{cm}, and were accurately graduated to hold 10^{cm^3}.

A mirror suitably situated beneath the box containing the tubes gave efficient illumination. Such an apparatus is not only cheaply and easily procured, but if tubes of these dimensions are used it is capable of accurately determining very small amounts of gold.

The method of comparison was carried out in the following manner. A measured amount of the suspension was drawn off into the left hand tube and diluted to the mark with water; a suitable amount of water was then placed in the right hand tube and the standard suspension drawn into the tube until the colors were seen to be identical. The necessary amount of water to be used can be determined by preliminary experiment.

The positions of the tubes were always reversed before the final reading was taken.

The following experiments were made in order to determine the error and range of amounts of gold capable of accurate estimation in such an apparatus with tubes of the dimensions described above. The comparisons were made with a red suspension prepared by careful dilution of a more concentrated standard suspension which contained 0·000010175 grams of metal in one cm^3.

The results obtained with different concentrations of the standard suspension just described are given in the following table.

TABLE II.

No. Ana.	Gold sus. taken. cm^3.	Gold sus. used. cm^3.	Gold used. grm	Gold found. grm.	Error. grm.
1	9·50	9·05	0·000102	0·000097	−0·000005
2	8·00	7·59	0·000086	0·000082	−0·000004
3	7·00	6·89	0·000075	0·000074	−0·000001
4	6·00	5·83	0·000065	0·000063	−0·000002
5	5·00	4·84	0·000054	0·000052	−0·000002
6	4·00	3·88	0·000043	0·000042	−0·000001
7	3·00	2·47	0·000032	0·000027	−0·000005
8	2·00	1·82	0·000022	0·000020	−0·000002
9	1·00	0·93	0·000011	0·000010	−0·000001

The intensity of the color in the above experiments ranged from a deep red to a faint pink. Further comparisons made with suspensions more dilute than those described above gave errors of magnitude increasing with the dilution. The amounts handled here are, then, the minimum quantities that can be accurately estimated with the apparatus described. It is obvious that if larger amounts of the metal are to be determined, tubes of greater dimensions should be used.

The application of such a method for the determination of gold naturally starts with that element. The weighed amount of metal, contained in a clean porcelain crucible, can be readily brought into solution with the aid of chlorine water or aqua regia and the excess of the solvent evaporated off upon the water bath. Experiments have shown that a gentle preliminary heating of the solution of the auric salt hastens the rapidity of the reduction. Care must be taken not to reduce any of the gold chloride by such a procedure.

If traces of electrolyte are present the coagulation of the "red" gold may be sometimes avoided by the addition of a few drops of ether to the cold solution. When small amounts of the metal are handled the volume of the solution should not exceed a few cubic centimeters, and only a small amount of the aqueous solution of acetylene should be added; otherwise the coloration may be partially or totally inhibited.

In conclusion, it can be seen from the evidence of the experiments described above, that the colorimetic estimation of small amounts of gold is quantitatively possible if proper precautions are taken to ensure the maximum coloration and exclusion of electrolytes. The method is quick and simple in character, and for the amounts of gold used above, the results show it to possess suitable accuracy for the correct estimation of small amounts of the metal.

The author wishes to acknowledge his indebtedness for much helpful aid and advice in this, and in previous work, to Professor Gooch, at whose suggestion these experiments have been carried on.

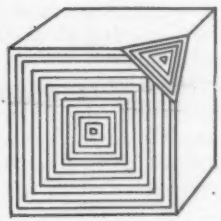
ART. XXI.—*Cobaltite Occurring in Northern Ontario, Canada*; by JUSTIN S. DE LURY.

THE vein containing the cobaltite described in this note is situated in the southeastern part of Coleman Township, on the claim owned by Mr. John Columbus, which is near the recently discovered cobalt-silver mines of Northern Ontario, The country rock, Huronian slate-conglomerate, contains most of the valuable deposits of the district. The bulk of the vein matter is quartz, which contains, besides the cobaltite, small quantities of chalcopyrite and pyrite. The part of the vein containing the cobaltite crystals varies from six to eight inches in width.

The mineral crystallizes in cubes and octahedra, but usually in combinations of these two forms. It is of a pure silvery white color, except on some weathered faces which have a red tarnish. The crystals are very brittle, and when broken show a rough uneven fracture.

Owing to the brittleness of the crystals, good specimens for examination can be obtained only from weathered portions of the vein. Some of these crystals were carefully cleaned and examined on a Goldschmidt two- circle goniometer. The cubic and octahedral faces, although giving sufficiently good reflections to determine them as such, were much pitted and striated (see fig. 1), thus giving a series of reflections. Several crystals were examined and of all the reflecting faces only one was found which did not correspond to the cubic or octahedral positions; it corresponded more closely to (342) than to any other form. However, since it was the only occurrence of this form, it may be safer to assume that it is not a crystal face but a contact face.

1



	I.	II.	III.
Co	29·10	29·17	35·54
Fe	4·55	4·72	----
Ni	0·97	1·68	----
As	44·55	44·77	45·18
S	20·73	20·23	19·28

An analysis was made of powder obtained from carefully cleaned crystals. The result of this analysis is presented in column I. For purposes of comparison an analysis of cobalt-

ite from Nordmark* is given in II, while in column III the percentage conposition corresponding to the formula, CoAsS, is appended.

Professor G. R. Mickle of the School of Practical Science, University of Toronto, obtained some of the vein-matter from Mr. Columbus' claim in October 1905, and presented it to Professor T. L. Walker of the University of Toronto, who kindly gave it to the writer for examination.

Chemically, physically and crystallographically, this note adds little to our knowledge of cobaltite. However, as this is the first authentic discovery of the mineral in North America, it is worthy of being recorded. Leonhard,† in 1843, describes its occurrence in Connecticut in a conglomerate, but Dana does not recognize this locality.

Mineralogical Laboratory, University of Toronto, Jan., 1906.

*Flink, Ak. H. Stockholm Bihang, xii (2), No. 2, 5, 1886.
†Top. Min., p. 321, 1843.

Art. XXII. — *Wasatch and Wind River Primates;* by F. B. Loomis.

The Amherst College expedition of 1904 made a considerable collection of Primates from the Wasatch and Wind River beds, especially from the latter, which are the basis of the following study, supplemented by reference to other collections from the same horizons.

Anaptomorphidae Cope.

The genus Anaptomorphus was established by Cope when he described the Bridger species, *A. aemulus*,* known by a single but nearly complete lower jaw. In 1882 the Wasatch species, *A. homunculus*, was added to the genus,† being an unusually complete skull. Later, lower jaws were found, and the lower dentition mostly made out. The type species has but eight teeth in the lower jaw, the formula being $i\frac{2}{2}$ $c\frac{1}{1}$ $pm\frac{3}{3}$ $m\frac{3}{3}$; while the lower jaw of *A. homunculus* is not so much shortened, having apparently nine teeth in the series, making a formula $i\frac{2}{2}$ $c\frac{1}{1}$ $pm\frac{3}{3}$ $m\frac{3}{3}$.‡ Then while in *A. aemulus* the paraconid is wanting, in *A. homunculus* it is present though reduced. These two marked differences led Wortman to suggest§ that these two species should be placed in different genera, but for lack of more abundant material, he did not propose a new one.

In the Wasatch the Amherst expedition found one new Anaptomorphus, little over half the size of *A. homunculus;* and nine specimens of a second new species in the Wind River beds. While these do not add to our knowledge of the generic features, their rarity and the interest in American Primates seems to require their description. They are both closely related to *A. homunculus* and should a new generic name be proposed would go along with that species.

The affinities of the family seem to the writer to be with the modern Tarsius, as pointed out by Cope (Tertiary Vert. 1884, p. 246) and Wortman. The latter authority has proposed the following classification of Primates,‖ which is adopted in this paper.

* Proc. Amer. Phil. Soc. Phila., 1872, p. 554.
† Proc. Amer. Phil. Soc. Phila., 1882, p. 152.
‡ See Osborn, Bull. Amer. Mus. Nat. Hist., vol, xvi, 1902, p. 200.
§ This Journal, 1904, p. 213.
‖ This Journal, 1904, p. 213.

- Primates
  - Cheiromyoidea — Gnawing forms like Cheiromys, Mycrosyops, etc.
  - Lemuroidea — Lemurs
  - Anthropoidea
    - Arctopithecini
    - Palaeopithecini
    - Neopithecini
      - Adapidae
      - Cebidae
      - Cercopithecidae
      - Simiidae
      - Hominidae

Anaptomorphus minimus sp. nov.

The type consists of a portion of the right mandibular ramus, containing molars 1 and 2, and a part of premolar 4, found in the lower Wasatch at the foot of Tatman Mt., Wyoming.

1

FIG. 1. *Anaptomorphus minimus*, type, ×5.

The teeth are wide and low with acute cusps, the talonid being slightly larger than the trigonid. The paraconid is distinct and stands close to the inner margin of the tooth. The protoconid is connected with the paraconid by a long low protolophid, and with the metaconid by a comparatively high metalophid. The hypoconid and entoconid are of about equal size. No hypoconulid is present.

Specific characters are found in the position and development of the paraconid, and the extreme small size of the animal. The two lower molars measure together $3{\cdot}4^{mm}$ in length and $1{\cdot}4^{mm}$ in width; the depth of the jaw under molar 2 is $3{\cdot}2^{mm}$.

Anantomorphus homunculus Cope.

For excellent figures and description of this species, see Osborn, Bull. Amer. Mus. Nat. Hist., vol. xvi, p. 200, and comparisons in the table on the following page.

Anaptomorphus abbotti sp. nov.

The type consists of a right mandibular ramus containing premolars 3 and 4 and molars 1–3, found in the middle beds of the Wind River formation on Bridger Creek, Wyoming. The species is named for Mr. L. F. Abbot, to whose interest much of the success of the expedition was due.

The molar teeth are low with low cusps, but rise progressively to the fourth premolar, which has a prominent crown. All the teeth in the short jaw are compressed from front to back, making them proportionally wide. A distinct cingulum runs along the front and external side of each molar. On

ANAPTOMORPHIDAE.

	A. homunculus	*A. abbotti*	*A. minimus*
Premolar 3	Internal cingulum Posterior cingulum slightly raised medianly	No internal cingulum Posterior cingulum raised medianly	
Premolar 4	Posterior cingulum not raised	Posterior cingulum raised medianly	
Molar 1	Trace only of cingulum Protolophid short Metalophid low Talonid larger than trigonid	Strong cingulum in front and outside Protolophid very short Metalophid low Talonid larger than trigonid	No cingulum Protolophid long and low Metalophid high Talonid only slightly larger than trigonid
Molar 2	Trace only of cingulum Paraconid close to metaconid Protolophid low Metalophid low	Strong cingulum in front and outside Paraconid close to metaconid Protolophid low Metalophid moderate	No cingulum Paraconid very distinct Protolophid low and long Metalophid high
Molar 3	Trace only of cingulum Paraconid small but distinct Metalophid low and notched Talonid about equal to trigonid	Strong cingulum in front and outside Paraconid a mere rudiment Metalophid deeply notched Talonid longer than trigonid	
Horizon	Wasatch	Wind River	Wasatch
3 molars' length	6·5mm	7mm	About 4·5mm

molar 1 the paraconid is strong and well separated from the metaconid; on molar 2 it is less independent; and on molar 3 is barely distinguishable. The last molar is small, the talonid elongated and narrow with a strong hypoconulid; the hypoconid and entoconid being merely indicated on the raised margins running from the hypoconulid forward. On molars 1 and 2 the hypoconid and entoconid are well developed, and the hypoconulid is wanting. The fourth premolar has a high protoconid over the front root, and the merest rudiment of a deuterconid beside it. The posterior cingulum is raised

medianly, suggesting a hypoconulid. The third premolar is two-rooted, and has but a single cusp. Its posterior cingulum is also raised medianly, suggesting a forming cusp.

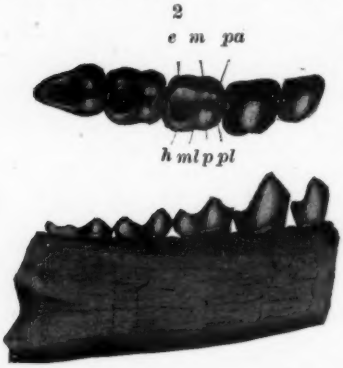


FIG. 2. *Anaptomorphus abbotti*, type, ×4.

Specific features are found in the external cingulum of the molars, the elongated talonid of molar three and in the raised posterior cingulum of the third and fourth premolars.

Nine specimens were found on Bridger Creek in the Wind River beds.

The three molars measure 7^{mm} in length and molar 2 is 2^{mm} wide.

*Adapidae Schlosser.**

In this family the American genus Notharctus approaches the European genus Adapis closely, especially the new species *N. minutus* from the Wind River. Two genera are represented in America, the simpler and apparently ancestral Pelycodus from the Wasatch, and the more advanced Notharctus of the Wind River and Bridger.

The family may be defined as follows; dentition $i\frac{2}{2}$ $c\frac{1}{1}$ $pm\frac{4}{4}$ $m\frac{3}{3}$; molars low crowned and with low cusps; paraconid reduced but present; external cusps more or less crescentic; hypoconid small; the last lower molar with a weak and varying heel.

The family makes its appearance in Europe and America suddenly and at almost the same time, apparently migrating from some northern center of distribution onto the two continents; the climate being a warm temperate or tropical one, as shown by the fauna† and flora collected in the basal beds of the Wasatch by the Amherst expedition.

The two genera are distinguished as follows:

Pelycodus	*Notharctus*
Outer cusps of lower teeth more or less conical:	Outer cusps of lower teeth more or less crescentic:
No mesostyle on upper teeth:	Mesostyle on upper teeth:
Hypocone weak:	Hypocone strong:
Heel of last lower molar large, tending to have two or more cusps:	Heel of last lower molar weak with a single cusp only:
Fourth lower premolar simple.	Fourth lower molar complex.

*Affer, Lemuren, Chiropteren, etc., 1887, Pt. 1, p. 21.
† Wortman, this Journal, 1903, p. 419.

Pelycodus Cope.

The genus is founded on *P. jarrovii* from the New Mexico Wasatch, the type among others from that region having disappeared. Specimens of the various species are abundant throughout the Wasatch of the Big Horn basin and run up into the Wind River, where they give place to the more specialized Notharctus. On Bridger Creek, Wyo., where a rich pocket of Wind River was found, Notharctus specimens were second in abundance to Hyposodus only. While several species occurred, the smaller sorts were the more abundant.

Pelycodus frugivorus Cope var.

This, the smallest and most abundant of the Wasatch species, was founded by Cope on a portion of a jaw from New Mexico; and, on account of the correspondence in size, the Big Horn specimens have been associated with it. While the two faunas closely resemble each other, and are doubtless closely related, the northern species differ slightly from the southern; for which reason the writer has used the variety designation. In this instance the last lower molar of the New Mexico form has fewer cusps on the less developed heel, than does the Big Horn.

The species is characterized by low chunky teeth; a moderate external cingulum on the lower molars; the last lower molar having an elongated heel with three small cusps occupying the position of the hypoconulid; the hypoconulid of molars 2 and 3 being small and situated close to the hypocone.

FIG. 3. *Pelycodus frugivorus* Cope, var., ×2.

In the position of the hypoconulid and development of the cingulum, the species is closest to *P. tutus;* in the modifications of the heel it is nearer *P. nuniensis.* Specimens were collected from all levels in the Wasatch on Gray Bull River and in the Buffalo Basin. The last three lower molars measure very uniformly 15^{mm} in length and 4^{mm} in width.

Pelycodus tutus Cope var.

Like the foregoing, this species is based on a New Mexico fragmentary mandible, which carried only the third and fourth premolars and the first molar. Like the foregoing, the Big Horn specimens vary, especially in the premolars, the third premolar being simpler, and the fourth having the two principal cusps much closer together.

The species is marked by stout low teeth; an external cingulum on the lower molars; the hypoconulid of molars 1 and 2 being small and close to the hypocone; the last lower molar being shortened and having but one cusp on the heel, the hypoconulid.

4

FIG. 4. *Pelycodus tutus* Cope var., ×2. The last molar is restored, the original being crushed.

The species is close to *P. frugivorus*, but differs especially in the larger size, and in the single cusp on the last lower molar. The species is rather rare on Gray Bull River, only four specimens being found. The last three lower molars measure 18^{mm} in length and 4½^{mm} in width.

Pelycodus jarrovii Cope.

See Final Rep. Surv. West of 100th Meridian, vol. iv, 1887, p. 137.

This large species from New Mexico has not been found elsewhere as yet. It is marked by a simple heel on the last lower molar, on which is merely a wall without any cusps. The hypoconulid of molars 1 and 2 is barely perceptible.

The three lower molars measure 20^{mm} in length.

Pelycodus angulatus Cope.

Last cit., p. 144.

This is a dubious species founded on a single molar tooth from New Mexico.

Pelycodus nuniensis Cope.*

This is the only species of Pelycodus to carry over into the Wind River, and is by Osborn considered a transition to the Notharctus species. However, on account of its stocky build it appears to the writer a typical Pelycodus.

The species is marked by low stout teeth; the third lower molar having its heel elongated and carrying two cusps where the hypoconulid is usually situated; the hypoconulid of molars 1 and 2 being small and central in position; and the paraconid being weak.

While the last lower molar resembles *P. frugivorus*, the species is larger and chunkier, and has the hypoconulid placed

* See Bull. U. S. Geol. Surv. Terri., vol. vi, 1881, p. 187.

medianly. It is fairly common in the Bridger Creek beds,

5

FIG. 5. *Pelycodus nuniensis* Cope, ×2.

eight specimens being found. The last three molars measure 16^{mm} in length and $3\frac{1}{2}^{mm}$ in width.

Notharctus minutus sp. nov.

This, the smallest species of the family, is founded on a right mandibular ramus, containing the molars and the roots of the third and fourth premolars, found in the Wind River beds on Bridger Creek, Wyoming.

The low teeth have rather acute cusps, those on the trigonid being higher than those on the talonid. The external cusps are strongly crescentic. The paraconid is moderately strong, and stands well to the inner margin of the tooth. There is a strong protolophid but no metalophid, so that there is a basin on the trigonid as well as on the talonid. The heel of the last

6

FIG. 6. *Notharctus minutus*, type, ×5.

molar is surrounded by a raised rim on which there are no cusps. There is a strong external cingulum on all the molars. The form is a tiny one, and the jaw very slender.

The crescentic cusps, lack of a metalophid, and the basin on the trigonid causes the species to strongly resemble the European genus Adapis. Three specimens were found on Bridger Creek. The three lower molars together measure 5^{mm} in length.

Notharctus palmeri sp. nov.

This small form is abundant in the Wind River beds of the Bridger Creek exposure. The type is two fragments of the lower jaws of one individual, the one containing the left fourth premolar, the other carrying the second and third molars of the right side. The species is named for W. W. Palmer on account of his success in collecting in these beds.

The fourth premolar has but a trace of an external cingulum and a well developed posterior cingulum on which two cusps are developed, the larger to the outer side. On the molars there is also but a trace of an external cingulum. The last molar has the hypoconid and entoconid about equally developed and a small medianly placed heel on which there is a moderate hypoconulid.

The species differs from *N. cingulatus* in the lack of the cingulum and in the median position of the heel on molar 3. While eleven specimens were found, they are mostly very fragmentary, the jaws being extremely fragile. The three lower molars measure 11^{mm} in length and 2·7^{mm} in width.

FIG. 7. *Notharctus palmeri*, type, ×3. A, the fourth premolar of the left side; B, molars 2 and 3 of the right side.

FIG. 8. *Notharctus cingulatus*, type, ×3. A, premolar 4 and molars 2 and 3 of the right side; B, molar 3 of the left side.

Notharctus cingulatus sp. nov.

This second small form is about equally abundant with the foregoing in the Wind River beds of Bridger Creek. The type is a right mandibular ramus containing the fourth premolar and molars 1 and 2. With it is associated a third molar of the left side which may belong to the same individual.

While similar to the foregoing, the species is distinctive in that the fourth premolar has a complete external cingulum, and the posterior cingulum is simply raised medianly into a cusp-like process. Molars 1 and 2 have an almost complete external cingulum. The last lower molar has the hypoconid larger than the entoconid; and the small hypoconulid on a small heel, placed toward the inner side of the tooth.

Twelve specimens of this species were found on Bridger Creek. The three lower molars measure together 11^{mm} in length and 2·7^{mm} in width.

Notharctus venticolus Osborn.*

This is a larger species founded by Osborn on the Wind River specimens which Cope had associated with *P. tutus*. None were found in the Bridger Creek locality. The three lower molars measure 17^{mm} in length.

Amherst Biological Laboratory.

* Bull. Amer. Mus. Nat. Hist., vol. xvi, 1902, p. 195.

	P. frugivorus	*P. tutus*	*P. nuniensis*	*N. minutus*	*N. palmeri*	*N. cingulatus*
Premolar 3	Cingulum on front, inside, and rear	Cingulum on rear				
Premolar 4	Cingulum inside and rear Rear cingulum not raised	Cingulum mostly in rear Rear cingulum raised medianly	Cingulum in rear only, Rear cingulum raised medianly		Cingulum behind only Rear cingulum with two cusps	Cingulum outside and rear Rear cingulum raised medianly
Molar 1 and 2	External cingulum weak Protolophid weak Metalophid weak Hypoconulid small near hypoconid	External cingulum strong No protolophid Metalophid none Hypoconulid small near hypoconid	No external cingulum No protolophid Metalophid moderate Hypoconulid moderate median	External cingulum strong Protolophid strong Metalophid none Hypoconulid none cusps crescentic	External cingulum as a trace only Protolophid moderate Metalophid weak Hypoconulid moderate near hyoconid	External cingulum moderate Protolophid strong Metalophid strong Hypoconulid small near hypoconid
Molar 3	External cingulum weak Protolophid weak Metalophid weak Heel long with 3 cusps	External cingulum strong Protolophid none Metalophid none Heel short with 1 cusp	External cingulum none Protolophid none Metalophid weak Heel long with 2 cusps	External cingulum strong Protolophid weak Metalophid none Heel moderate with a rim only	External cingulum as a trace only Protolophid strong Metalophid weak Heel small central with 1 small cusp	External cingulum moderate Protolophid strong Metalophid strong Heel small to inner side with 1 small cusp
Horizon	Wasatch	Wasatch	Wind River	Wind River	Wind River	Wind River
Length of 3 last molars	15mm	18mm	16mm	5mm	11mm	11mm

Art. XXIII.—*A New Occurrence of Pseudo-Leucite;** by C. W. Knight.

Through the kindness of Dr. A. E. Barlow of the Canadian Geological Survey there came into the possession of the writer two rock specimens whose characters are herewith described. Mr. R. G. McConnell of this Survey collected the material during the summer of 1904 and has sent this note regarding the field relations:

"The leucite rock described in the following paper occurs in the Ogilvie range on the upper part of Spotted Fawn creek, a tributary of Twelve-mile river, Yukon Territory. It occurs in a long dyke-like area about a mile wide where crossed. It is bordered on the north by a reddish granitoid rock, probably a syenite, and on the south by altered sedimentaries, mostly quartzites and slates of Upper Palæozoic age. It has suffered considerable deformation, the leucite crystals in places being crushed into lines.

"The leucite rock is probably intrusive rather than effusive in character, although the examination was too hurried to obtain definite information on this point. It appeared to be older than the syenite and younger than the sedimentaries."

The work was carried on in the geological laboratory of Columbia University, New York, and the writer would express his acknowledgments to Professor Kemp and Dr. Berkey for advice and assistance.

Specimen A is of a medium gray color and perfectly fresh. The ground-mass is very fine-grained and the constituent minerals cannot be distinguished with the naked eye. The principal phenocryst occurs in well developed icositetrahedrons usually less than 1^{cm} in diameter. Fig. 1 is a photograph of two of these phenocrysts showing their crystal form. In color they resemble the ground-mass of the rock so as not to be distinguished from it. They, however, are readily separated from the matrix. The crystal habit is that of the mineral leucite, though in the microscopical examination given later on no trace of an isometric mineral was found. A few sanidines tabular in form and generally less than 5^{mm} in diameter are also seen to play the part of phenocrysts.

Specimen B is quite similar to the one just described with the exception that it has not as many of the icositetrahedral crystals. Instead are seen grayish white, rounded areas 5^{mm} in diameter with apparently no crystal form. Both specimens show a striking resemblance to the pseudo-leucite tinguaite

* Published by permission of the acting Director of the Canadian Geological Survey.

from the Bearpaw mountains in Montana, described by Weed and Pirsson.*

Thin sections from specimens A and B when examined under the microscope showed the rock to be made up of the following minerals: orthoclase, pseudo-leucite, nephelite, scapolite and biotite. The first three minerals play the part of phenocrysts; orthoclase and nephelite also appear in the ground-mass and consequently occur in two generations.

Orthoclase:—The ground-mass consists largely of orthoclase laths, showing flow structures. They exhibit a tendency to flow around the pseudo-leucite. Wavy extinction is always observed with crossed nicols. These laths average about ·1^{mm}

1

FIG. 1. Pseudo-leucite crystals from Spotted Fawn Creek, Yukon Territory, Can. The crystal form (icositetrahedron) is that of the mineral leucite. Diameter of large pseudo-crystal is 1^{cm}. The crystals have been very slightly flattened by pressure.

in length, while the phenocrysts, which often show the common Carlsbad twins, average 5^{mm} in diameter.

Pseudo-leucite:—These extremely interesting and puzzling pseudomophs consist of the following minerals: orthoclase, scapolite, nephelite, biotite and a very little plagioclase. The *orthoclase* is most abundant and occurs under two conditions: first, in allotriomorphic grains, less than ·1^{mm} in diameter, generally concentrated in the more central portions of the pseudo-crystals; second, in lath-shaped individuals often concentrated on the outer borders and oriented in such a way that their longer axes lie normal to the crystal faces of the pseudo-leucite (see fig. 2). It is a striking fact that this border arrangement appears to be a characteristic of the pseudo-leucites from Brazil, Magnet Cove, Arkansas, and the Bearpaw Mountains, Montana. Williams in his description of pseudo-leucites from Magnet Cove has referred to this arrangement of the orthoclase as a "palisade" structure.† The allotriomorphic

* On some Phonolitic Rocks from Montana, this Journal, vol. i, p. 394, 1895, see also vol. ii, Aug. and Sept. 1896, p. 194.

† The Igneous Rocks of Arkansas—Annual Report Geol. Sur. Arkansas, vol. ii, 1890, p. 268.

grains of feldspar are almost always quite clear and fresh ; the lath-shaped individuals around the borders, however, generally show incipient kaolinization and are in consequence cloudy when examined with one nicol. The *scapolite* is recognized by its low relief, high interference colors reaching the yellows and reds of the first order, cleavage cracks crossing at right angles, parallel extinction and the distinct unaxial cross of negative character which is readily observed in basal sections. It occurs in clear allotriomorphic individuals, generally irregularly

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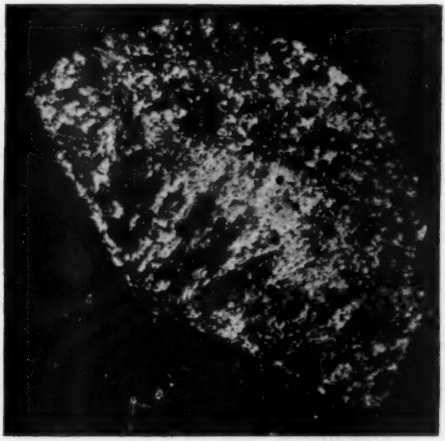

FIG. 2. Photo-micrograph of pseudo-leucite ; crossed nicols ; actual field 2·5mm. Near the border the lath-like orthoclase individuals lie with their longer axes more or less normal to the faces (icositetrahedral) of the crystal. In the central portions the small allotriomorphic orthoclases are seen.

distributed throughout the pseudo-leucite, but sometimes also gathered together in little groups ·4mm in diameter. In some instances the individual scapolites reach a diameter of nearly 1mm, but it generally occurs in grains much smaller than this. It was observed in one case to have the appearance of being formed directly from nephelite; and further, the grains of scapolite sometimes occupy areas whose boundaries are distinctly quadratic—a characteristic form of nephelite. It should be noted here that scapolite has not been described before as occurring in pseudo-leucite.

The remaining three minerals which are seen in the pseudo-crystals are *nephelite, biotite* and an acid *plagioclase* feldspar. The first of these occurs in allotriomorphic and quadratic sections, showing low relief and low interference colors. Basal

sections give a distinct uniaxial cross, negative in character. The mineral does not seem to be abundant, but a more careful examination with high powers shows it to be present in greater amount than would at first appear. Wavy extinction, as observed in the orthoclase, is likewise seen in the nephelite. The *biotite* occurs in grains always less than ·05^{mm} in diameter. It is a greenish brown variety, strongly pleochroic. The tiny plates tend to arrange themselves along lines; again they are segregated into patches 1^{mm} or so in diameter, or are irregularly distributed throughout the pseudo-crystals. A very few individuals of an acid *plagioclase* feldspar were noted.

It has been already stated that the pseudo-leucites in specimen B do not appear to possess a crystal form when examined macroscopically. Under the microscope, however, some crystal faces are observed. It is possible that the absence of distinct crystal form may be due to the action of the magma on the original leucite crystals. Apart from the form of the crystals the microscopic description given above applies equally well to the pseudo-leucites of both specimens.

Nephelite:—A few crystals with quadratic cross-section and low interference colors give uniaxial interference figures negative in character. They occur in the ground-mass with one exception; in this instance a crystal 1·2^{mm} in diameter plays the part of a phenocryst; the mineral gelatinized easily in HCl. Nephelite is not an abundant mineral in the rock.

Scapolite:—Besides occurring as a constituent mineral of the pseudo-leucite, scapolite also forms part of the ground-mass. It is readily recognized by those characters already enumerated above. In size the grains will average less than ·05^{mm} in diameter.

Biotite:—The orthoclase laths and biotite make up the principal minerals in the ground-mass. The biotite occurs in plates, generally less than ·1^{mm} in diameter, lying in the interstices of the feldspar laths. It is a greenish brown variety, strongly pleochroic and appears to be similar to that found in the pseudo-leucite crystals.

Though nephelite does not play a prominent part, the rock is nevertheless here classified as a *pseudo-leucite phonolite.* It is highly probable, however, that nephelite was once present in greater amount than it is now, since the scapolite appears to be secondary after it.

The pseudo-leucites studied in this paper resemble very closely those from Brazil; from Magnet Cove, Arkansas; from the Bearpaw Mountains, Montana; from Beemerville, N. J.; and from the Highwood Mts., Montana. O. A. Derby* described the porphyritic types of foyaite from Brazil containing

* Quart. Jour. Geol. Society, May, 1891, p. 251.

"segregations" which present the aspect of crystals or groups of crystals. These consist of orthoclase, nephelite, augite, hornblende and titanite, with the crystal form of leucite. The marginal layer, rarely absent, is composed of lancet-shaped orthoclase (with nephelite) disposed normally to the faces of the pseudo-crystals. The peculiar masses were studied by Graeff and Hussak;* the former regarded them as inclusions of pre-existent foyaite; the latter looked upon them as true pseudo-crystals representing a tendency to the formation of leucite under physical conditions unfavorable to the complete development of that mineral. Derby suggested "that perhaps crystals of leucite exceedingly rich in inclusions (phenocrysts from the surrounding magma) were actually formed; but that before the complete consolidation of the magma, some change of conditions brought about, through magmatic action, a pseudomorphosis of the leucite molecule into orthoclase and nephelite."

As will be shown below, the pseudo-leucites from Spotted Fawn Creek, Yukon Territory, have about the same chemical composition as those from Magnet Cove, Arkansas, described by J. F. Williams.† At the latter locality they are found in leucite-syenite dikes and leucite-tinguaites. The pseudo-crystals occur in icositetrahedrons 5^{cm} in diameter and consist of a network of allotriomorphically bounded, tabular crystals which are generally arranged in radial forms and which are often interspersed with small allotriomorphic eleolite crystals and idiomorphic pyroxenes. The orthoclase crystals often lie with their symmetry-planes at right angles to the edge of the section and hence forming a sort of palisade about the edge. In the slide of this material examined by the writer it was at once noted that the minerals composing the pseudo-leucite were coarser in grain than in the pseudo-crystals from the Yukon territory. Wavy extinction was also noted in the crystals from Magnet Cove. Williams' hypothesis regarding their formation is similar to that of Derby. He says "they began to form under conditions favorable to the formation of leucite and, as is frequently the case with true leucite crystals, they included all sorts of foreign particles, such as magnetite and aegirite. The conditions then changed and instead of becoming true leucites their substance was recrystallized and the leucite molecule was broken up into eleolite and orthoclase."

The pseudo-leucites described by Weed and Pirsson‡ from the Bearpaw Mountains, Montana, occur in icositetrahedrons

* Neues Jahrb. 1887, vol. ii, p. 255; and 1890, vol. i, p. 166.

† Annual Report Geol. Sur. Arkansas, 1890, vol. ii, "Igneous Rocks of Arkansas."

‡ This Journal, vol. i, p. 394, 1895, 4th series. See also vol. ii, 1896 (4), p. 194.

which average 1^{cm} in diameter. They consist of an allotriomorphic mosaic of orthoclase and nephelite. "In some cases the outer edge of the section is composed of orthoclase crystals with their longer axes perpendicular to the crystal faces of the original leucite." A thin section of the Bearpaw pseudo-leucite examined by the writer contains in its center an isotropic kernel, whose outline resembles the figure 8. Part of the feldspar surrounding the kernel radiates out from this material, giving a spherulitic structure to this part of the slide. It may be that the orthoclase and nephelite have been formed directly from the isometric kernel, or, in other words, this isometric substance might be regarded as a remnant of the *original leucite crystal.* Prof. Pirsson, however, has proved by chemical tests that the material is either sodalite or analcite and not any original unchanged leucite substance. The material examined by the writer was too small to permit the use of microchemical tests.

Prof. Wolff* studied a leucite-tinguaite from Beemerville, N. J., which contains pseudo-leucites similar to those described above. They are made up "of an aggregate of orthoclase, partly in irregular grains, more often in radiating prisms." Between the orthoclase a comparatively small amount of nephelite occurs. The centre of the pseudo-crystals contains an isotropic mineral determined as analcite. Near the same district Prof. Kemp† examined a basic dike consisting of biotite and pyroxene set in a ground-mass that is chiefly analcite. In portions some curious, spheroidal inclusions appear having a diameter up to 10^{mm}; they are made up chiefly of analcite and are always rounded and without crystal form. In the fresh material Prof. Kemp was able to show that the spheroids consisted partly of leucite. These pseudo-crystals have, however, evidently been formed by surface alteration and differ in this respect from the pseudo-leucite from Yukon territory and the other localities mentioned above.

Prof. Pirsson‡ described pseudo-leucites from the Highwood mountains, Montana, consisting of alkali feldspars, nephelite and small amounts of what is held to be analcite. They occur in a "granular intrusive rock consisting of dominant leucite with subordinate augite." These pseudo-crystals are similar to those already described.

In order to study the chemical composition of the pseudo-leucites from the Yukon territory, and also to compare them

* Harv. Coll. Mus. Comp. Zool. Bull., vol. xxxviii, p. 273-277, 1902.

† This Journal, 3d series, vol. xlv, p. 298-305, 1895; also vol. xlvii, May 1894.

‡ Bull. 237, U. S. Geol. Surv. p. 83.

with other occurrences, two crystals were selected for analysis. The crystals, which were of a medium gray color with two or three white streaks running through them, broke away very readily from the ground-mass. This fact seems to indicate that the original leucite on breaking up into orthoclase, nephelite and plagioclase contracted so that it could be isolated easily from the ground-mass. It also goes to show that the breaking down of leucite probably occurred when the rock had entirely solidified, but was still at a temperature not far below its fusion point. Fig. 1 is a photograph of the two crystals analyzed; their actual diameters are about 1^{cm}.

	A. Spotted Fawn Creek, Yukon Territory.	B. Magnet Cove, Arkansas.	C. Mt. Vesuvius.
SiO_2	58·15	55·06	58·30
Al_2O_3	23·66	25·26	23·80
Fe_2O_3	1·59		
CaO	0·43	0·60	0·96
MgO	0·21	0·28	0·17
Na_2O	7·08	7·60	5·80
K_2O	8·49	10·34	10·94
H_2O-	0·10		
H_2O+	1·25	1·78 (ignition)	
Cl	trace*		
	100·96	100·92	99·97

* Present, but not determined.

A. Spotted Fawn Creek, Yukon territory, Canada; analyzed by C. W. Knight.

B. Magnet Cove, Arkansas, analyzed by J. F. Williams.

C. Mt. Vesuvius, analyzed by Ramelsberg.

For comparison two other analyses are given in the above table. The close resemblance which the pseudo-leucites from Magnet Cove bear to those from the Yukon territory is at once noted. From the high amounts of Na_2O which are shown by the above analyses it seems clear in each case that the original mineral was a *soda-leucite*. On the presumption that the scapolite in the pseudo-crystals from the Yukon territory is secondary after nephelite and that consequently the leucite broke down into feldspar and nephelite, we may find the proportions in which these minerals occurred by recasting the analysis. The biotite may be considered as inclusions (or as a secondary product from inclusions) in the original leucite. Since only a small per cent of biotite is present, the amount of K_2O required for this mineral is not great. To obtain, therefore, an idea of the relative amounts of orthoclase, nephelite

and anorthite all the K_2O may be calculated as present in the orthoclase; this gives: Orthoclase, 50·04%; nephelite, 32·38%; anorthite, 2·22%.

The small amount of lime is considered to belong to the plagioclase, which as previously stated occurs in very subordinate quantities. It is thus obvious that the scapolite is composed essentially of the marialite molecule ($Na_4Al_3Si_9O_{24}Cl$).

The pseudo-leucites from the various localities previously enumerated have generally three common characteristics: (*a*) the crystal form of the icositetrahedron, (*b*) the "palisade" structure about the border, (*c*) the similarity of the constituent minerals.

Though the only specimen containing scapolite is that from the Yukon territory, still it seems highly probable that the scapolite in this case is secondary after nephelite and that consequently the original leucite broke down into orthoclase (with a small amount of plagioclase) and nephelite. The general resemblances just enumerated would appear to indicate that all these pseudo-crystals were formed under somewhat the same conditions. Just what those conditions were must still be a point open for discussion. It is believed by the writer that the mineral originally crystallized out, in the intra-telluric period of the magma, as a *soda*-leucite, that after the entire magma had solidified the leucite changed over into orthoclase, nephelite and subordinate plagioclase, and that still later the nephelite (both in the pseudo-leucite and in the ground-mass of the rock) changed partly into scapolite.

Leucite, which under any circumstances is a very unstable compound, is evidently rendered much more so by the large replacement of K_2O by Na_2O. It would seem that the presence of the latter in such large amount was responsible for the change of the *soda*-leucite into orthoclase, nephelite and very subordinate plagioclase.

Geological Laboratory, Columbia University.

Art. XXIV.—*The Re-formation of Soda-Leucite;* by T. T. Read and C. W. Knight.

In the case of a steel containing ·5 per cent carbon the molten mass on cooling first solidifies at 1225° C. as austenite, a solid solution of carbon in iron. This may for our purpose be regarded as a mineral, since it has a definite crystalline form and distinctive properties. If cooled slowly the austenite becomes metastable at a somewhat lower temperature and breaks down into two components, ferrite (Fe) and cementite (Fe_3C), using the former term in the metallographic and not the petrographic sense. The temperature at which this takes place is sharply defined (near 750° C.) and the process is marked by an evolution of heat. If, however, the cooling is accomplished rapidly (e. g., by quenching in water) this rearrangement does not have sufficient time to take place and austenite is preserved at ordinary temperatures. This is the familiar process for the hardening of steel. Under these conditions the austenite possesses a constant tendency toward rearrangement, which is restrained by the lack of molecular freedom at this temperature. On heating, this restraint is lessened and the austenite begins to effect the rearrangement, finally completing it at about the temperature at which it would have taken place with slow cooling. On raising the temperature slightly above this point austenite is again formed and may be preserved by quenching as before.

Following the line of thought suggested by these facts, it occurred to one of the authors* that if the crystals of pseudo-leucite could be heated to somewhat above the temperature at which the rearrangement to orthoclase and nephelite had taken place, soda-leucite would be yielded, which might then be preserved by rapid cooling. The slightest fusion of the crystal must, of course, be avoided. If the rearrangement in the pseudo-leucite is entirely analogous to that in the steel, then this change would be effected by temperature alone. But to make the analogy complete the heating should be effected at the pressure at which the rearrangement originally took place. Since this could not be ascertained, an attempt was made to cause the formation at atmospheric pressure of soda-leucite from the products resulting from the rearrangement.

In order to gain some idea as to the temperature required to produce this change, a small crystal of the pseudo-leucite, carefully freed from adhering groundmass, was placed in a platinum crucible provided with a closely fitting cover and sub-

* T. T. Read.

jected to the highest heat of a Bunsen burner for 5½ hours. No noteworthy changes could be observed in a thin section made from the crystal thus treated.

Another specimen was then subjected to a constant temperature of 1225° C. in an electric furnace for ten hours. After cooling, a microscopic examination of the crystal in thin section showed parts to be isotropic. There still remained a considerable proportion of unalted orthoclase and nephelite. No traces of biotite or scapolite could be detected. The chlorine at this temperature would have been driven off, and with it perhaps some of the other constituents. The outer border was much darker in color and presented a glassy appearance. It was evident that the biotite had migrated to the border, forming a fused coating which had cemented the lower side of the crystal to the crucible. The shape of the crystal had not appreciably changed. The thin section showed the crystal to be full of globular holes about ·1^{mm} in diameter, due perhaps to the loss of volatile constituents and the passage of the biotite to the outer border.

Even granting that the isometric material which had formed was leucite, the difficulty of distinguishing it from glass is obvious. It was considered that the temperature employed was too high, since the edges of the crystal had a glassy and fused appearance, while the object of the experiment was to effect, if possible, the change of pseudo-leucite into soda-leucite in the solid.

Another crystal was therefore subjected to a constant temperature of 1100° for 8 hours. In this time a small area had become isotropic and showed a few bubbles, but otherwise was clear and colorless. The biotite had fused to a dark glass but had apparently not migrated from its original position. No scapolite could be detected (the chlorine had of course been driven off at this temperature), but otherwise than in these respects the appearance of the section had not been markedly changed beyond a distinct accentuation of the relief.

At this point it became necessary to discontinue the work for the present. If opportunity shall permit, it is the hope to continue it to more definite conclusions, but in the meanwhile it seemed wise to give an account of the preliminary work, as suggestive for discussion and perhaps research by others.

Both the authors are greatly indebted to Dr. M. N. Bolles of the Department of Metallurgy, who kindly conducted the heating in the electric furnace.

Department of Geology, Columbia University.

Art. XXV.—*Orotaxial Significance of Certain Unconformities;* by Charles R. Keyes.

The unconformable relationships which some of the greater geological formations bear to one another in the Rocky Mountain region have been widely noted. Most of the observations bearing upon this theme have been made in Colorado and the states to the north and west. In this region, however, the full significance of the various unconformities which have been recognized cannot be measured. In each instance the values are qualitative and not quantitative.

The region mentioned has continued to be the theater of mountain-building from very early geological times. For this reason very largely the record of its geologic history is broken and obscured, and it is necessary to go into neighboring states to complete the account. To the southward in New Mexico conditions are quite different.

Soon after passing the south Colorado boundary the southern Rocky Mountains rapidly lose their imposing character and the last vestige is seen in the pitching anticline near the Glorietta pass, on the Atchison, Topeka and Santa Fe railroad, a few miles from the city of Santa Fe. Southward from this point, even to beyond the Mexican boundary 300 miles away, deposition has been more complete and continuous and repeated erosion less destructive than further northward.

In a given region it has been customary to write its geological history from the sediments alone. Gaps, even when recognized, have been passed over with little or no comment. Geologic history has, however, an erosional record that is about as long and fully important as the depositional record. The preserved erosional surfaces are the planes of unconformity. It is to some of the most important of these phenomena, as they have been recently made out beyond the southern Rocky Mountains, and to some of their depositional equivalents that attention is here called.

A decade and a half ago, S. F. Emmons, in a paper read before the Geological Society of America* on the Orographic Movements in the Rocky Mountains, mentioned the fact that from earliest Archean times this region has been one of upheaval. The author above mentioned, after reviewing the geological literature relating to this broad expanse of country, notes in the general geological column ten more or less marked unconformities.

In recent years, the same subject has been again broached, but from a somewhat different standpoint and in a neighboring province. More than double Emmons' number of great uncon-

*Bull. Geol. Soc. America, vol. i, pp. 245–286, 1890.

formities have been found, and the positions of these are indicated in the accompanying table of the major geological formations of New Mexico. For present consideration the chief value of the section lies in the surprising number of great unconformity horizons and in the presence of extensive formations which are represented by gaps in the rock-succession farther north in the Rocky Mountain region.

Since the time-value of the unconformity plane has been seldom measured quantitatively in sediments, and since every local geological section has an erosional as well as depositional record, the former is not measurable in the locality in which it is found, but finds expression in sediments in other and neighboring localities. One of the most remarkable instances of exact equivalency of this kind is found in the unconformity plane in the Upper Mississippi valley at the base of the productive Coal-measures. The depositional equivalent of this erosion plane is believed to be found on the south side of the Ozark dome in Arkansas, where the measurement is more than 18,000 feet. Southward beyond the end of the Rocky Mountains in New Mexico and the adjoining states conditions exist very similar to those in the Ozark region. Depositional equivalents of some of the gaps farther north are here found. Unconformities are also displayed in a way that enables the geological history to be made out with very much greater clearness than anywhere else. In this southern region, where mountain-making movements have not been so great as further northward, there has been recognized, as already noted, no less than a score of great unconformities, beside many of minor importance. The general geological section of this region, together with the horizons of unconformity, are given below.

Out of the 25 rock series which have been defined, there are only two (and possibly two other) exceptions in which these major formations are not separated by great planes of unconformity representing profound erosion intervals. The time-values of these various gaps in sedimentation no doubt differ very much among themselves; but they are all great. For instance, in central New Mexico, the Cimarronian Red Beds rest directly upon the Maderan limestones, with marked unconformable relationships. In southern New Mexico this interval is partially occupied by no less than 2,500 feet of sand stones and limestones. The relationships are indicated by dia gram (fig. 1).

Little is known as yet of the unconformities of the Proterozoic within the boundaries of New Mexico. The presence of a pre-Cambrian clastic sequence has only been very recently recognized with certainty* and differentiated from the Archeozoic crystallines. There appear to have been several ero-

*Eng. and Mining Jour., vol. lxxvi, p. 967, 1903.

Great Unconformities in the New Mexican Succession.

	Age.	Series.	Thickness.	Rocks.
Cenozoic	Quaternary	(Not differentiated)	200	Gravels
	Tertiary	Llano Estacadan	200	Shales
		Arriban	500	Sandstones
		Wasatchan	1700	Sandstones
		Nacimientan	800	Shales
Mesozoic	Cretaceous	Laramian	3600	Sandstones
		Montanan	1500	Shales
		Coloradan	1000	Shales
		Dakotan	500	Sandstones
		Comanchan	100	Sandstones
	Jurassic	Morrisonian	200	Shales
	Triassic	Zunian	1200	Shales
		Shinarumpan	1500	Shales
Paleozoic	Carboniferous	Cimarronian	1000	Shales
		Guadalupan	2500	Limestones
		Maderan	1000	Limestones
		Manzanan	1000	Limestones
		Ladronesian	100	Shales
		Socorran	300	Limestones
	Devonian	(Not differentiated)	400	Limestones
	Silurian	(Not differentiated)	100	Limestones
	Ordovician	El Pasan	1200	Limestones
	Cambrian	Tontoan	300	Sandstones
Proterozoic		Chuarian	3000	Shales
		Grand Canyon		Sandstones
		Vishnuan		Quartzites
Archezoic		(Not differentiated)	5000	Schists

sion intervals. These may correspond to the three principal unconformities found farther west in Arizona. In northern New Mexico the three planes are believed to be superimposed.

The Paleozoic formations older than the Manzanan limestone (Mid-Carboniferous) are found only in the southwestern part of New Mexico, around the southern margin of the broad dome known as the Colorado High Plateau. To the north all

have been removed through erosion prior to the Manzanan period. In the south all of the series bear unconformable relationships to one another.

The thick Manzanan and Maderan limestones are widespread. They are found exposed in all of New Mexico west

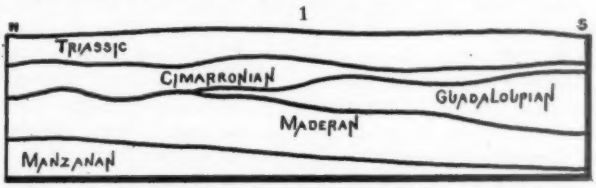

FIG. 1. Relationships of Late Carboniferous Formations south of the Rocky Mountains.

of the Pecos river and the Rocky Mountain front. They form the foundation of the entire High Plateau dome to the Grand Canyon. In all this vast region no trace has yet been discovered of any formation occupying the interval between the upper surface of the great limestone plate and the Red Beds. In southeastern New Mexico in the Guadalupe range there are over 2,500 feet of sandstones and limestones in this interval. This is the Guadalupan series and carries an extensive fauna, first made known by Shumard in 1858, but unknown elsewhere on the American continent.

The Red Beds are widespread. Very marked unconformities occur both at the base and at the top. Whether they are Permian or Triassic in age has long been a theme of discussion. A great unconformity lately determined in the very middle of the Red Beds succession appears to clearly separate the inferior Carboniferous part from the superior Triassic portion.*

Special interest centers in the probable existence of Jurassic deposits in the Morrisonian and Zunian formations. The general stratigraphic relationships are represented below (fig. 2).

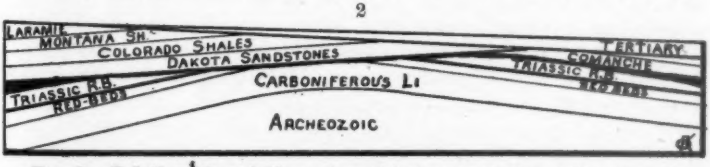

FIG. 2. Relationships of Mesozoic and Paleozoic Rocks of Northern New Mexico.

As for the other unconformities they may be passed over for the present.

In the course of the work of delimitating the formations composing the geological section of New Mexico, as set forth

* This Journal, vol. xx, pp. 423–429, 1905.

in this brief statement, the relative values of the biotic methods and a purely physical or orotaxial method have been strongly contrasted. For half a century the fossils of the region have been studied and the most that has come out of it has been only the geological age determined in the most general way. For the rock-succession few sharp lines have been developed and drawn by this means.

On the whole, recourse of late has been had only to the physical breaks in sedimentation. These bounding planes have given in the field both criteria for formational separation and precise data for quantitative correlation. The former have been surprisingly practical in their application. The latter are particularly instructive on account of furnishing many instances in which dependence upon fossils has been largely done away with. In fact, in the working out of the general scheme, aid from the contained organic remains of the different geological formations has been received only in a most general way, and frequently only as an independent check, among several other distinct methods. The paleontological conclusions usually lag so far behind the deductions derived from other sources in the field that in this as in other numberless cases they are almost useless as practical aids. They come in after the important questions have been already conclusively settled.

In several instances fossils have had to be neglected altogether, since the evidence afforded by them was so indecisive. Some of these cases present similar conditions to those described by McGee for the middle Atlantic slope, where he stated that "during the past two or three years more has been learned of the stratigraphy of the formations through physical means than through biotic methods in the previous 50 years."

One of the most instructive facts brought out by the present physical scheme has been the manifest necessity of complete revision of many conclusions arrived at through purely paleontological means. In such regions as the Rocky Mountains, where the rock formations are exposed on such a much grander scale than in more humid parts of the country, the fossils can never have the importance which they have in the last mentioned areas; in fact, their use may be largely done away with, and in actual practice they are very generally neglected. This fact the paleontologists have failed to take cognizance of, at least as far as published accounts indicate. Attention has been also called to this fact by Emmons, King, and others who have worked in the Rocky Mountain field, but who have not had to depend wholly upon the fossils in their stratigraphic efforts.

In the periods of mountain-building and in orogenic movement a quantitative measure of a regional geologic record is believed to be found.

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ART. XXVI.—*Some Phosphorescent Calcites from Fort Collins, Colo., and Joplin, Mo.;* by WM. P. HEADDEN.

THE calcites discussed in this article possess the property of becoming phosphorescent on being insolated and retain this property, in some cases, for a period of thirteen hours. Ordinary calcite under like conditions phosphoresces for one-third of a second and aragonite for twenty seconds. Many other minerals become phosphorescent on being insolated, but the duration of this phosphorescence is very brief.

The specimens described in this article are from two localities, Fort Collins, Colo. and Joplin, Mo. The Colorado specimens occur as a vein of calcite cutting through the Fort Benton shales. No distinct crystals have as yet been found at this locality. The specimens from this locality are inferior to the Missouri mineral in all respects, particularly in regard to the brilliancy of the phosphorescence. The best specimen from this locality was quite strongly phosphorescent after insolation, it was observed for two and one-half hours, when the observation was abandoned though the specimen was still phosphorescent.

The Missouri specimens occur in two forms, both in well defined crystals. One is the well-known dog-tooth spar, only slightly modified by a rhombohedron; the other is a combination of two scalenohedrons. The crystals of dog-tooth spar are as a rule quite large, and have, exteriorly, a yellow color; the crystals showing a combination of two scalenohedrons are smaller and their interior portion is yellow, while the outer portion is colorless or in some instances slightly violet. The change from the yellow to the colorless calcite in these crystals is sometimes shown very distinctly by a crop of chalcopyrite crystals which have formed on the surfaces of the more obtuse scalenohedron.

The Missouri specimens show a stronger phosphorescence and are in other respects better fitted for the purposes of this investigation than the Colorado ones. The following data, therefore, have been obtained from the Missouri mineral.

The occurrence of wine-colored crystals of calcite at the lead and zinc mines near Joplin, Mo., is well known, but I do not know the mine or mines from which my specimens were obtained. In the case of the dog-tooth spar, the wine-yellow color is due to the deposition of a yellow calcite in the last stages of their growth. The interior portions of these crystals are seldom if ever yellow, but are colorless or violet if transparent and white if opaque. The other type of crystals have yellow centers and a colorless or violet-tinged outer portion.

The yellow calcite alone possesses the property of phosphorescing in the sense that I use this term. The first sample which we found to possess this property had an irregular purple patch near its center, which appeared as a dark area in the mass of yellow light. Repeated observations on cleavage pieces which were partly yellow and partly of some other color fully justify the preceding statement. In such cases the phosphorescence was always limited by the line of growth which marked the change from the yellow to the other color, whatever it was, white, purple or colorless.

The duration of this phosphorescence in the yellow calcite was as much as thirteen hours, which was established by continuous observation. The duration actually exceeded this time, but one's eyes and judgment too become more or less unreliable after hours of watching, especially as this light not only becomes very feeble, but also assumes a ghastly whiteness before it fades out entirely. The phosphorescence was distinctly visible, however, in some specimens, for the time given, thirteen hours.

These experiments were made in both the summer and winter seasons. An insolation for any considerable time in the summer season produced a sensible increase in the temperature of the mass; this probably had some effect upon the intensity and duration of the phosphorescence in the samples observed at that time. I insolated a large specimen for thirty minutes at a temperature of $-3°$ C., when it was found to be strongly phosphorescent. I did not determine the duration of this phosphorescence, but I could not perceive any diminution in its intensity at the end of two hours. A variation of temperature from $-3°$ to $+25°$ C. does not, so far as our observation goes, materially affect the character and duration of the phosphorescence.

I endeavored to observe whether this phosphorescent light would give a spectrum or not; but the results were unsatisfactory. The action of this light on a photographic plate was tested by exposing a Seed's gilt edge dry plate to the action of the light emitted by a large, strongly phosphorescent crystal for 30 minutes. The portions of the plate intended to receive the action of the light were not protected in any way. There was no action at all on the plate, it was perfectly clear when developed.

Phosphorescence can be excited in the yellow calcite by the electric spark, also by the X-ray. The phosphorescence excited by the passage of the spark for a few seconds was observed for thirty minutes, but it had in this time become quite faint. A number of cleavage pieces of the Joplin mineral of different colors and a piece of Iceland spar were exposed to bombardment by the X-ray: they all became phosphorescent, but the

Iceland spar ceased to phosphoresce very quickly; so did the colorless, the white opaque and the purple pieces of the Joplin mineral, while the yellow was still phosphorescent at the end of an hour.

Burning magnesium provokes phosphorescence in the yellow but not in the other varieties, Iceland spar included. The duration of this phosphorescence was not determined, but it exceeded ten minutes.

The time of exposure to the action of these agents varied greatly, but it will be recognized that my object was to study the deportment of these calcites and not the relation of the intensity and duration of the phosphorescence to the intensity and time of action of the agents causing it. The shortest insolation timed was four minutes and it produced a strong phosphorescence. Our insolations were made at various times of the day, from early morning till after 5 o'clock in the evening, with apparently equally good results. The yellow calcite emits light when crushed or powdered: the light is yellow and there is no danger of mistaking it for the light emitted when an agate or porcelain mortar is rubbed with its pestle. The yellow calcite becomes phosphorescent when heated. Small pieces heated in an air bath began to phosphoresce when the thermometer indicated a temperature of 60° C., but the larger pieces introduced at the same time did not begin until the thermometer showed 75°. The phosphorescent light emitted by the heated pieces is reddish yellow, almost salmon-colored, and fades rapidly especially if the temperature has been raised to 180° or higher. If the temperature has been raised to 100° and the specimens removed, the phosphorescence fades rapidly at first but afterwards quite slowly.

Some of the samples burst when heated to 180°, possibly due to liquid inclusions; the appearance of some of the pieces suggested the presence of such, but none were actually observed. Heating to 200° does not destroy the property of the calcite to become phosphorescent on subsequent insolation, but ignition does.

If a piece of insolated calcite be brought into a heated air bath, the character, intensity and duration of the phosphorescence is modified and deports itself as though the phosphorescence had been produced by heating alone.

The size of the pieces of calcite insolated has but little or no effect on the intensity or duration of the phosphorescence. In one instance a piece weighing less than two-tenths of a gram was the brightest one in the tray and was still recognizable as such at the end of one and a half hours.

In the large number of insolations made we met with but two exceptions to the statement that the yellow calcites become phosphorescent by insolation. I have not discovered the reason for these two exceptions. The cause was not due to

the calcites themselves, for they were subsequently insolated and phosphoresced brightly.

I have stated that ignition destroys the property of becoming phosphorescent by insolation, so does solution; neither the solution itself nor the carbonates recovered from it by fractional precipitation show this property.

A yellow color in the Joplin calcite seems to be a sure indication that the sample will become phosphorescent upon insolation. Two things suggested themselves as possible explanations of these properties, the presence of sulphides and of organic matter, but I was unable to detect the presence of either of these. It, however, still seemed probable to me that this property was due to the chemical composition of the yellow portion: with this idea in view I submitted a carefully selected portion of the yellow calcite to analysis. This analysis gave but little promise that I might succeed by pursuing this method of investigation, as the percentages obtained for the calcic oxide and carbonic acid were almost exactly those required by theory. The precipitate, usually composed of ferric and aluminic oxide, amounted to less than 0·10 per cent, but it was the deportment of this precipitate that led me to repeat the analysis. The small amount missing in my first analysis, an amount less than 0·20 per cent, proved to be the interesting part of the mineral, whose analysis finally presented the following results:

Analyses of Yellow Calcite from Joplin, Mo.

SiO_2	0·032
CO_2	43·950*
SO_3	trace
H_2S	none
P_2O_5	trace
Cl	trace
CaO	55·740
SrO	trace
MgO	0·113
MnO	0·045
FeO	0·046
ZnO	0·014
Al_2O_3	trace
Cr_2O_3	trace
Ce_2O_3	0·007
Di_2O_3, Sm_2O_3, La_2O_3	0·012
Yt_2O_3, Er_2O_3	0·013
NH_3	trace
Na_2O	trace
Total	99·975

* One hundred grams of selected material gave 10^{cc} of gas not absorbed by KOH solution.

The analysis gives us no definite information relative to the cause of the phosphorescence, but merely an unusual though not an unknown fact relative to the composition of calcites. The presence of ceric oxide in certain limestones has been observed before; and Sir William Crookes has shown the presence of samaria and yttria in calcite, coral, etc.; but this is the first time, I believe, that these elements have been found in such notable quantities.

There are a few persistent peculiarities that have presented themselves in the course of this work which are worthy of an exhaustive investigation. The solution of the ceric oxides in hydrochloric acid shows, in addition to the lines of didymia, an extra line in the violet beyond the didymia line charted at 133–134. This line is easily observed by the aid of a small direct-vision spectroscope.

The ceric oxides obtained in this analysis have the following colors; the ceric oxide, CeO_2, has a pale rose-red color; this probably indicates the presence of a little didymia, though the cerous hydrate was suspended in a strong solution of potassic hydrate and treated with chlorine until the potassic hydrate was saturated, then gently heated, filtered, washed, etc.; and again submitted to the same treatment. This was repeated three times and still the ceric oxide appears to contain didymia.

The filtrates from the precipitate of ceric hydrate were precipitated by the addition of oxalic acid. All of these precipitates gave either a very light green oxide,—a greenish gray might be more descriptive of this oxide, or a green with a tinge of brown; this may be praseodidymia but it is more probably a mixture of didymia and samaria, which would account for the brown tinge in some of the portions and the light brown of two portions which no heat that I have been able to obtain with the blast lamp has changed in the least. There is no direct proof of the presence of lanthana; its presence has been taken as a matter of course.

The oxalates of the yttria group yielded on ignition a yellowish white oxide whose solution in hydrochloric acid gave an excellent spectrum for erbia. In working with this group I observed that there is an oxalate present which is quite insoluble in cold water and in oxalic acid, but is quite soluble in hot water. If the oxalates be first washed with cold water and then with boiling water, the oxalate will crystallize out of the hot wash water as it cools. According to the data that I find given, yttria oxalate is the most soluble oxalate in this group, and of it the statement is, that it is almost insoluble in pure water. This oxalate gives with ammonia a white precipitate similar to yttria and the other members of this group. I do not think that this is due to yttria because this oxalate can be completely

washed out of the oxalate precipitate, so that the boiling wash water will neither yield any crystals on cooling or give a precipitate with ammonia, even after concentration, though there is still yttrium in the precipitate. I have been compelled to postpone the further investigation of this precipitate until I may be able to command more material and greater resources than I have at the present time.

The presence of an oxide which is precipitated by ammonia in the presence of tartaric acid, and which is precipitated by oxalic acid from a solution containing free hydrochloric acid, but not by a saturated solution of potassic or sodic sulphate, is taken as conclusive proof of the presence of yttria. The characteristic absorption spectrum of erbia is relied upon as establishing its presence, but the question of the presence of the other members of the group is held in abeyance.

We have not as yet gained even a hint in regard to the cause of this property of the yellow calcite, i. e. of phosphorescing after insolation. I have not met with any statement which would lead one to infer that the presence of zinc or of any member of the yttrium or cerium group in the form of carbonate would impart this property to the calcium salt. The salts of the rare earths, the ignited yttria sulphate excepted, seem to show phosphorescence in a weak and rather unsatisfactory degree even when exposed to the action of the cathode ray in a radiant matter tube. When calcium is present the deportment of yttria and samaria is radically changed, especially in regard to the phosphorescent spectrum that they give. Some such fact may obtain in this case of phosphorescence after insolation.

A very large amount of work was done of which no record appears in this article, but the results of which serve as the basis for the following statements; the total amount of rare earths may be greater in a non-phosphorescent than in a phosphorescent calcite; the oxides of the yttria group are relatively more abundant in the phosphorescent than in the non-phosphorescent; the white, opaque calcite contains less zinc oxide and a much smaller amount of the rare earths than the yellow, phosphorescent portions.

The second of these statements is illustrated by the ratios found for the yttrium and cerium groups in the following four instances; in a sample of yellow, strongly phosphorescent calcite the ratio of the yttrium to the cerium oxides was $1\frac{1}{2} : 1$, in another sample of yellow calcite this ratio was $1 : 1$, but in two samples of feebly or non-phosphorescent material this ratio was $1 : 2{\cdot}4$ and $1 : 2{\cdot}6$ respectively. The weight of calcite used in making these determinations was 500 grams in each case.

The white, opaque cleavage pieces, obtained by breaking up crystals of dog-tooth spar, have in no instance been observed

to be phosphorescent after insolation. Analysis shows that the rare earths are present in such pieces, but in less than one fifth of the maximum quantity found in other samples, while the zinc oxide was a little more than one half the amount found in the best material.

We are dealing with such small quantities and it is so difficult to select samples of 500 or even 50 grams that shall be uniform in their contents of these elements, that we should be careful to duly consider the possibility of variation in the samples selected, and further, the probability of error, for it is a delicate task to determine such small quantities of these elements.

If the question is one of chemical composition, it is evident that we are compelled to consider the unusual things, those which in this case are present in minute quantities, as imparting this remarkable property. If this view be correct, the common accidental constituents of calcite such as ferrous, ferric, manganous, magnesic and probably zinc oxide are eliminated from our consideration.

In describing this calcite I have mentioned purple as a rather common color in these samples or rather in portions of them. This is seemingly an insignificant fact, especially if we assume, as is usually done, that the pink, violet and purple is due to some manganese compound. The purple due to manganese, particularly as permanganate, gives a characteristic absorption spectrum; accordingly the purple portions of the cleavage pieces were examined with aid of the spectroscope. The light from an incandescent lamp gives an excellent continuous spectrum when viewed through the yellow or the colorless calcite, but a pronounced black line appears whenever a purple portion passes between the lamp and the slit of the spectroscope. If the purple color is intense enough two lines appear. No sample examined failed to give the stronger of these two lines very satisfactorily indeed. These two lines coincide with the α and β lines of didymia, which fact was ascertained by using a solution containing didymia, when the lines produced by the purple portions of the calcite were found to be coincident with the α and β lines of the solution and are, therefore, probably due to this earth.

The analytical results justify the inference that the yttrium group has a greater influence upon the phosphorescence of the calcite than the cerium group; and this inference is greatly strengthened by the spectroscopic proof that the didymia can readily be detected in portions of the crystals which have not, under any conditions, been observed to phosphoresce. As cerium, lanthanum and samarium are usually if not always associated with didymia, one is justified in assuming that the

other members of the group which occur in the mineral are present in the purple portion also and probably play but a small part, if any, in imparting this property of phosphorescing to the calcite.

The phosphorescence is confined to the yellow portions of the mineral, and those having the deepest yellow color, such as pass into a brownish yellow shade, show the strongest phosphorescence. Our failure to detect any organic coloring matter suggests very strongly that we are to find the cause of the phosphorescence in the presence of some element whose salts are yellow. My interpretation of the facts is that they point to the yttrium group or some member of it, whether it is at present known to chemistry or not, as the cause of this property. It may be only a coincidence, but it is a fact that the deeper brownish yellow portions of the calcite are strongly suggestive of the brownish yellow of xenotime, and had phosphoric acid been present in this calcite in more than a very minute trace, we might, with a fair show of reason, have inferred the presence of the phosphate of yttria, but there is only a trace of phosphoric acid and the phosphate of yttria cannot be present. I do not, however, intend to convey the impression that yttria may not be the cause for which I have been searching, for at the present time I am inclined to think that it is.

It may seem marvelous, even to the chemist, that an amount of any substance so small as we are evidently dealing with in this case, should be capable of producing such striking and beautiful effects as I have endeavored to describe. It is marvelous but not incredible. Sir William Crookes has been able, by means of the phosphorescent spectrum, to detect one part of yttria or samaria when diluted with one million parts of lime, and the one part of samaria continued to cast its shadow, so to speak, on the spectrum in the presence of two millions five hundred thousand parts of lime.

The figures deducible from my analyses are scarcely suggestive of such infinitesimal quantities as these, still it is possible that the substance actually causing this wonderful sensitiveness to sunlight and imparting the power to give it out again for so long a time may be present in no greater quantity than one part in two millions five hundred thousand.

The limit of my present progress is the establishment of a probability that these calcites owe their property of becoming phosphorescent on insolation to the presence of some member of the yttrium group which is represented by 13 parts in each 100,000 parts of the calcite.

Colorado Agricultural College, Fort Collins, Colo.

Art. XXVII.—*On the Chromates of Cæsium;* by Frank Roy Fraprie.

Of salts of cæsium and chromic acid, there have been described a chromate and a bichromate, neither of which have been thoroughly investigated. Cæsium chromate was apparently first made by Retgers,* who studied its isomorphism with the other alkaline chromates without describing the salt itself. It was prepared in "beautiful clear yellow needles several centimeters long" by Chabrié† in 1901, after the present study was begun. The bichromate was first mentioned in 1885 by Soret,‡ who prepared cæsium chrome alum from commercial bichromate, and was described by Chabrié (loc. cit.) as "small crystals of a brilliant clear red."

In the present investigation the following salts have been prepared:

Cs_2CrO_4 α (Rhombohedral-hemihedral)
Cs_2CrO_4 β (Orthorhombic)
$Cs_2Cr_2O_7$ (Triclinic)
$Cs_2Cr_3O_{10}$ (Rhombohedral-hemihedral)

Cæsium Chromate α, Cs_2CrO_4.

This salt was prepared in Cambridge in 1901–2 by adding an excess of silver chromate suspended in water to a solution of cæsium chloride. The cæsium chloride used was prepared by Mr. E. H. Archibald for the determination of the atomic weight of cæsium, and was spectroscopically free from traces of other alkali metals. The cæsium chromate was filtered by suction and evaporated to small bulk, when a small quantity of silver chromate separated. This was filtered off, and the nearly saturated solution was allowed to crystallize in a desiccator. The crystals obtained at ordinary temperatures, instead of being orthorhombic, like the potassium and ammonium salts, were long hexagonal prisms, of a very pale yellow color, almost colorless when transparent. They are perfectly stable in either dry or moist air. They contain no water of crystallization. An analysis for chromium gave the following result:

Salt taken.	Barium chromate.	% CrO_3 found.	Calculated.
0·2874 g.	0·1900 g.	26·12	26·22

A crystallographic examination of the crystals was made. They consisted of a combination of the hexagonal prisms of the first and second order equally developed, with a single

* Retgers, Ztschr. physikal. Chem., 1891, viii, 24–63.

† Chabrié, Comptes rendus, 1901, cxxxii, 678–681; Ann. chim. phys., 1902, (7) xxvi, 212–228.

‡ Soret, Arch. sci. phys. nat., 1885, (3) xiv, 96; Comptes rendus, 1885, ci, 156–157.

pyramid the faces of which could not be measured on account of etching. Many crystallizations were made before well-terminated crystals were obtained, as the slightest rise in temperature of the solution caused etching, owing to the considerable change in solubility of the salt, and the pyramid faces were first attacked. By removing the crystals at a time when the temperature of the solution was falling, very perfect crystals were finally obtained and the pyramid measured on a two-circle goniometer. With the exception of some indeterminate line edges in the prism zone on one or two etched crystals, no other forms were observed on these crystals. The angle from the pole of the prism zone (corresponding to the absent basal pinacoid) to the pyramid was found to be 39° 23′.

Many attempts were now made to crystallize isothermally at from 50° to 70° in a thermostat. The solubility increases so markedly at high temperatures that the solution always got down to very small bulk before crystallization commenced, and crystals could only be got by allowing the solution to go to dryness. These crystals were naturally not ideal for measurement, and only one crop was obtained, at 70°, which gave crystals with measurable pyramids. These gave the same value as those crystallized at ordinary temperature.

The hypothesis of compressible atoms* suggested that crystals grown under pressure might exhibit a change of habit or angles due to unequal atomic compression,—a change which might be preserved by the viscosity of the solid after the pressure was removed. Such a change, if demonstrated, might be the cause of the irregularities to be observed in the angles of minerals. Accordingly experiments under pressure were next made in a Hempel bomb, to which could be attached an oxygen generator. As the manometer was graduated only to twenty-five atmospheres, the highest pressure used was about twenty-eight atmospheres, most of the runs being made at twenty-three or twenty-five. The bomb was tight enough so that the diminution in pressure during the course of an experiment rarely amounted to more than one atmosphere. About forty experiments were made, some at the room temperature, some at various temperatures in a thermostat. The method was as follows: the cæsium chromate was contained in a tall, narrow, flat-bottomed glass tube, the solution being saturated and in contact with some undissolved salt. This tube was placed in the bomb on a leaden tripod which stood in concentrated sulphuric acid, used as a desiccating agent. As this on one occasion got into the chromate, it was afterwards replaced by sticks of caustic potash packed into the spaces between the walls and a cardboard tube surrounding the chromate tube.

*T. W. Richards, Proc. Amer. Acad. Arts and Sci., 1901, xxxvii, 1-17; 399-411.

The apparatus thus prepared was screwed up tight, connected with the oxygen generator, and heat applied to the latter until a sufficient pressure was reached, or until all the oxygen had come off. The generator was detached, and the bomb kept at the desired temperature in the thermostat for a period of from one to seven days. When opened, the crystals, if any were found, were removed from the liquid as hastily as possible, dried between filter papers, and examined. In the whole series of forty experiments not a single measurable crystal was obtained, the crystalline powder always consisting of irregular fragments mingled with very minute crystals. A microscopic examination often showed small perfect crystals.

Shortly before the end of the work in Cambridge, one crop of crystals was obtained at a pressure of twenty-eight atmospheres by heating the bomb in the thermostat at 70° for eight hours, and allowing it to cool slowly over night in the large tank of water. An excess of salt had been added to the solution, and a fair crop of crystals was obtained. While these was considerably etched, they gave readable signals, and from measurements of a number of crystals, it was found that the angles were the same, within the limits of error of reading, as on crystals grown under ordinary conditions.

The crystals of this crop differed in habit from those previously obtained, in that the predominant terminating plane was a rhombohedron, well developed on both ends of the crystals, and with its edges truncated by a pair of narrow faces of the pyramid ordinarily present. The faces of this rhombohedron were often slightly concave. For this reason, and because only ten faces could be measured, the axial ratio was calculated from the pyramid. The measurements follow:

Cs_2CrO_4 (Rhombohedral–hemihedral).

$$a : c = 1 : 1{\cdot}2314.$$

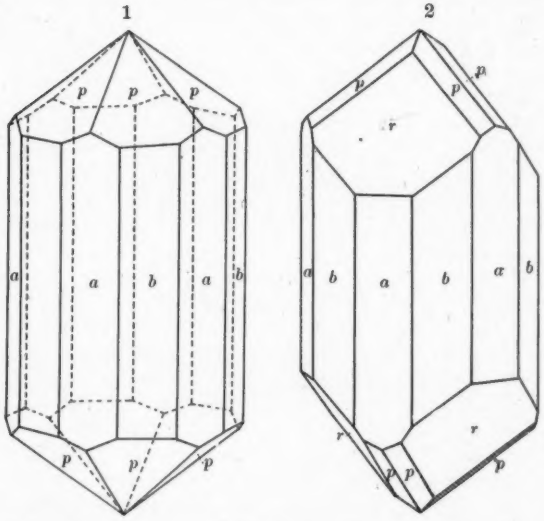
		Calculated.	Measured.	Readings.	Limits.
a r	$10\bar{1}0 \cdot 10\bar{1}1$	25° 7′	25° 0′	10	25° 19′–24° 21′
b p	$11\bar{2}0 \cdot 11\bar{2}3$		*50 37	34	50 42 –50 36
r r	$10\bar{1}1 \cdot 01\bar{1}1$	103 16			

Cleavage: basal, incomplete.

Forms: *a* ($10\bar{1}0$), *b* ($11\bar{2}0$), *r* ($10\bar{1}1$), *p* ($11\bar{2}3$).

The habit of the crystals is shown in figs. 1 and 2. Fig. 1 shows the crystals grown under ordinary pressure; they were apparently holohedral, invariably fully developed, with the six pyramid faces on each end all nearly equal in size, and with no trace of any rhombohedral face. Fig. 2 shows the rhombohedral crystals grown under pressure.

The growth of crystals under pressure was undertaken with the idea of ascertaining whether any change in habit or crystallographic constants could be produced by mechanical stress during the crystal growth. The results thus far obtained are not



ready for publication, and it is proposed to continue this work in the near future in the Chemical Laboratory of Harvard University.

Cæsium Chromate β, Cs_2CrO_4.

On one occasion some of the crystal powder taken from the bomb, composed of extremely minute particles, showed under the microscope, besides a few dark red bichromate crystals and large numbers of the ill-formed long pale hexagonal needles, two or three well-formed crystals of a very much deeper yellow color and bounded by definite planes and angles. The whole mass of crystals which had been separated from the mother-liquor and dried, was searched in the hope of finding some crystals of this character large enough to measure, but in vain. The mother-liquor had been set aside, and the next day, when it was sought for the purpose of making another experiment, it was unexpectedly found to contain several large, deep yellow, apparently orthorhombic crystals. Although they had partly redissolved, a measurement showed that they were orthorhombic, isomorphous with and composed of the same forms as are found on potassium chromate, cæsium sulphate, and the other members of this group. No further crystals of

this kind were obtained at Cambridge, from lack of time. On resuming the work at Munich in the fall of 1902, using another preparation of cæsium, only the orthorhombic crystals were obtained. The cæsium chromate used, obtained from Merck, was recrystallized twice as dichloriodide, and then converted into chromate as before. The orthorhombic crystals were analysed and found to be of the same composition as hexagonal ones, as follows;

Salt taken.	Barium chromate.	$\%CrO_3$, found.	Calculated.
0·3960 g.	0·2614 g.	26·12	26·22

Many attempts were now made to prepare the hexagonal crystals again, but absolutely in vain. Crystallization from either hot or cold solutions, quickly or slowly, always gave the same result, orthorhombic crystals. Only a small quantity of the formerly obtained hexagonal crystals was available, and repeated inoculations of solutions saturated and supersaturated with the orthorhombic salt had always the same result; the hexagonal crystals dissolved, and orthorhombic ones crystallized out. As the method of preparation in both places was the same, and the greatest care was taken in the purification of all materials used, and as the composition of the two salts is the same, it must be assumed that the hexagonal form is labile at ordinary temperature and pressure, and cannot exist in the presence of the orthorhombic form, although it may be possible to prepare it when no orthorhombic salt is present to start crystallization.

The measurements of the orthorhombic salt follow:

Cs_2CrO_4 β (Orthorhombic).

Axial ratio : 0·5640 : 1 : 0·7577.

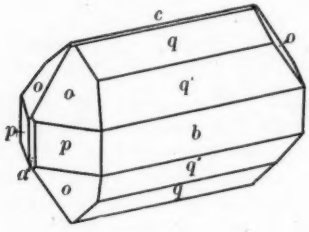
Faces.	Symbols.	No.	Mean.	Limits.	Calculated.	Difference.
bp	010 110	50	*60° 35′	60° 24′–60° 51′		
ap	100 110	4	29 25	29 21–29 29	29° 25′	±0′
pp	110 1$\bar{1}$0	13	58 50	58 36–58 57	58 50	±0
bq	010 011	46	*52 51	52 26–53 15		
cq	001 011	17	37 9	36 54–37 25	37 9	±0
qq′	011 021	10	19 23	19 6–19 35	19 16	+7
bq′	010 021	9	33 33	33 22–33 42	33 25	+8
ao	100 111	10	43 7	43 2–43 14	43 2	+5
oq	111 011	12	46 53	46 46–47 3	46 58	−5
op	111 110	26	33 3	32 55–33 12	32 57	+6
co	001 111	10	56 57	56 48–57 13	57 3	−6
bo	010 111	3	65 41	65 37–65 56	65 40	+1
	010 130				30 35	

Cleavage not observed.

Forms: *a* (100), *b* (010), *c* (001), *o* (111), *p* (110), *q* (011), *q′* (021).

The crystals vary much in habit. Often they are in the form of long yellow needles with no end faces, prismatic parallel to the *a* axis, and limited in length only by the width of the dish. Several crops were composed of prismatic crystals well developed on both ends, and once or twice the crop was composed almost entirely of interpenetration twins,

3



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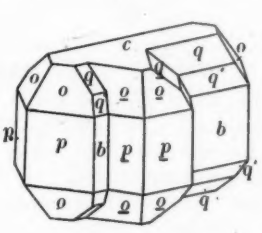


the twinning plane being 130, a face not observed on any crystal. The figures show a twin and a simple crystal. *a* (100) is rarely present and always very narrow, and the same may be said of *c* (001), except on the twins, where it is well developed. The other forms are always all present and of nearly equal development. The species is completely isomorphous with potassium sulphate and chromate.

Cæsium bichromate, $Cs_2Cr_2O_7$.

On one occasion when sulphuric acid got into the solution by the accidental breaking of a tube, the crop consisted wholly of microscopic red crystals of cæsium bichromate. These crystals seemed to be rhombohedra with apparently parallel extinction, but it was not possible to determine their system on account of their small size. An analysis for chromium resulted as follows:

Salt taken.	Barium chromate.	$\%CrO_3$ found.	Calculated.
0·1370 g.	0·1437 g.	41·42	41·55

The salt is quite insoluble, and is precipitated by the addition of sulphuric acid to a cæsium chromate solution. It was later prepared by adding an equivalent or more of chromic acid to the solution of chromate. It is then precipitated as an orange red power, much more soluble in hot water than in cold. An attempt was made to crystallize it in the "Schwedischer Topf," an apparatus for crystallization by very slow and uniform cooling, but even when the fall in temperature from 100° to 20 extended over a period of seven days, the crystals were so stri-

ated as to be useless for measurement. A single crystal possessed a prism zone from which blurred signals could be read to within a degree or so, and this measurement and the cleavage are sufficient to establish the isomorphism with potassium bichromate.

$Cs_2Cr_2O_7$ (Triclinic).

Axial ratio unknown.

Cleavage parallel to 001, perfect.

		$Cs_2Cr_2O_7$	$K_2Cr_2O_7$
$c\ q'$	001 $0\bar{1}1$	$66\frac{1}{2}°$	67° 23′
$q\ b$	$0\bar{1}1$ 010	25	26 57
$b\ q$	010 011	$31\frac{1}{4}$	30 46
$q\ c$	011 001	$58\frac{1}{2}$	54 54

An analysis of this salt gave the same result as the analysis made at Harvard of the salt precipitated by sulphuric acid.

Salt taken.	Barium chromate.	%CoO_3 found.	Calculated.
0·1592	0·1661	41·20	41·55

The occasional occurrence of orthorhombic crystals of entirely different form and color to those of the orthorhombic chromate, but not in sufficient quantity for investigation, suggests the probable existence of a second form of the bichromate. It is hoped that further investigation of this salt may be made in the near future.

$Cs_2Cr_3O_{10}$, Cæsium trichromate.

On further evaporation in the desiccator of the mother liquor from the bichromate, beautiful dark red rhombohedra of cæsium trichromate were deposited. An analysis resulted as follows:

Salt taken.	Barium chromate.	%CrO_3 found.	Calculated.
0·1845	0·2401	51·39	51·47

The habit of the crystals, which usually have one pair of rhombohedral faces very large, is apparently monoclinic, but a crystal with well-developed base showed the uniaxial cross very distinctly, and the measurements, although the crystals were not of the best, proved the hexagonal character. The trichromate is thus not isomorphous with any other trichromate. Mixtures of ammonium and rubidium trichromate crystallize in three systems, according to Wyrouboff,* monoclinic, orthorhombic, and hexagonal, but the present salt is of still a fourth form, trigonal.

* Wyrouboff, Bull. Soc. franc. min., 1881, iv, 120–135.

The measurements follow:

$Cs_2Cr_3O_{10}$ (Rhombohedral-hemihedral).

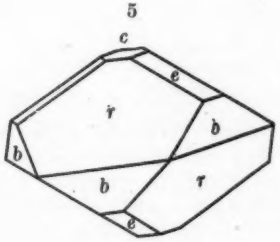
Axial ratio, $a : c = 1 : 1{\cdot}5549$.

Forms, r $(10\bar{1}1)$, e $(01\bar{1}2)$, b $(11\bar{2}0)$, c (0001).

Cleavage not observed.

Faces.	Symbols.	No.	Mean.	Limits.	Calculated.
cr	0001 $10\bar{1}1$	11	60° 58′	60° 49′–61° 29′	60° 53′
ce	0001 $01\bar{1}2$	7	42 5	41 43 –42 9	
re	$10\bar{1}1$ $01\bar{1}2$	49	*49 10	48 9 –50 13	
re	$10\bar{1}1$ $10\bar{1}\bar{2}$	11	76 55	76 51 –77 3	77 2
rb	$10\bar{1}1$ $11\bar{2}0$	4	40 50	39 33 –41 17	40 50
rr	$10\bar{1}1$ $01\bar{1}\bar{1}$	24	81 41	80 51 –82 33	81 40
rr	$10\bar{1}1$ $0\bar{1}11$				98 20

5



Summary.

This paper describes the preparation and crystallographic properties of two modifications of cæsium chromate, Cs_2CrO_4, of cæsium bichromate, $Cs_2Cr_2O_7$, and of cæsium trichromate, $Cs_2Cr_3O_{10}$, and leaves in doubt the existence of a second form of the bichromate.

It proves that a pressure of thirty atmospheres during the process of crystallization is not sufficient to produce any measurable difference of crystallographic axes or angles in hexagonal cæsium chromate, but makes it probable that it effects a change of habit in the crystals.

In conclusion I must express my thanks to Professor Theodore W. Richards and Dr. Charles Palache of Cambridge, and Professor Paul von Groth of München, for their encouragement and advice during the progress of this investigation.

Cambridge, Mass., and München, 1901–1903.

ART. XXVIII.— *Descriptions of two remarkable new species of Goliath Beetles (Dynastes) from Dominica Island, Antilles—Brief Contributions to Zoology from the Museum of Yale University, No. LXVI;* by A. HYATT VERRILL.

Dynastes tricornis sp. nov.

Male.—Elytra, thorax, and head polished, deep purplish black with no hair except along the edges of the segments, where the hairs are short, sparse, and rusty or ferruginous red; ventral surface highly polished, deep brownish black with very few sparsely distributed reddish hairs along the edges of the segments. Legs stout, black, and smooth, except along the tibiæ of the anterior pair, which are deeply but minutely pitted; tarsi and tibiæ edged with fine reddish hairs; processes of tibiæ very similar in form to those of *D. Hercules.* Dorsal outline of elytra broad, obtuse, and slightly compressed laterally at a point about one-third the distance between the anterior and posterior extremities.

Thorax shield-shaped in a dorsal view; concave in a lateral view and bearing three slender, smooth, curved, processes or "horns." The three horns are arranged in a triangle with the two posterior ones forming its base and curving forward and inward toward the third process, which forms the apex of the triangle; the anterior processes rounded below and flattened above, somewhat thickened near the center and curved semicircularly upwards at the outer end. No hairs on any of the thoracic processes.

Head minutely pitted and without appendages of any sort, except a small, slightly raised, transverse ridge between the eyes. Lateral posterior edges of the thorax below appendages and upper surface of anterior appendage minutely pitted.

Length from anterior extremity to tip of abdomen (exclusive of thoracic process), 1·45 inches; width of thorax at posterior segment, 0·60; width of thorax at widest point (across two posterior processes), 0·70; width of thorax at anterior segment, 0·25; width of elytra at widest point, 0·85; length of two posterior thoracic processes, 0·35; length of single anterior process, 0·45.

Habitat.—Highest mountain slopes of the island of Dominica. Several specimens. Female unknown.

As will be seen by the foregoing description, this new *Dynastes* is very distinct from any other species of the genus. Its small size, three thoracic and no occipital appendages, as well as its polished and uniformly colored surface are characters which serve to identify it at a glance.

In the arrangement of thoracic horns it resembles *D. Neptunus* from South America, but from this species it differs very materially. It appears to be very rare in Dominica, for during two years collecting in the island I have procured but few specimens, and it is unknown to most of the natives, who, as a rule, are fairly familiar with the fauna of the island.

Dynastes Lagaii sp. nov. Figure 1.

Male.—Much smaller than either *Dynastes Hercules* or *Vulcan* and averaging scarcely if any larger than *Dynastes tricornis.*

Elytra brownish olive, with a bright metallic luster in living specimens, sparsely and irregularly spotted with circular markings of deep brown, most numerous near the posterior extrem-

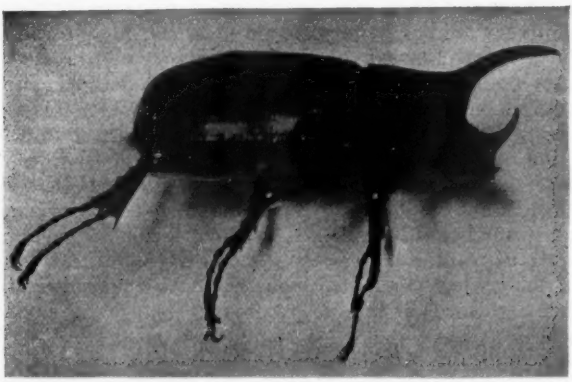


FIGURE 1. *Dynastes Lagaii.* Male, natural size. Type; phot. A. H. V.

ity and lateral and anterior edges. Thorax, head, abdomen, legs, ventral surface, edges of elytra and a broad band across anterior portion of elytra, rich chestnut-brown. Thorax with a short, cylindrical, slightly curved process.

Head with a stout, short, crescent-shaped process. Thoracic "horn" with a minute, scarcely perceptible process on either side at base. Occipital "horn" without protuberance of any sort except a very minute notch or tooth on the dorsal surface near the base.

Entire dorsal surface thickly and conspicuously pitted and everywhere covered with short, yellowish brown hair which becomes longer and conspicuous around the base of the occipital process, posterior portion of thorax, and along the median line of elytra. Ventral surface of thoracic process

covered with thick, velvety, golden-yellow hair. Ventral surface of head, thorax, and abdomen finely but thickly pitted, and with scarcely any hair except along the edges of segments and posterior extremity of abdomen; the latter with a long thick fringe of silky golden hair.

Female.—Scarcely distinguishable from female of *D. Hercules*, except by the much smaller size and abundant hair which completely covers the dorsal surface.

Length, exclusive of thoracic and occipital processes, 2·00 to 2·25 inches; length of thoracic process, 0·45 to 0·60; length of occipital process, 0·20 to 0·25; width of thorax at posterior segment, 0·80 to 0·85.

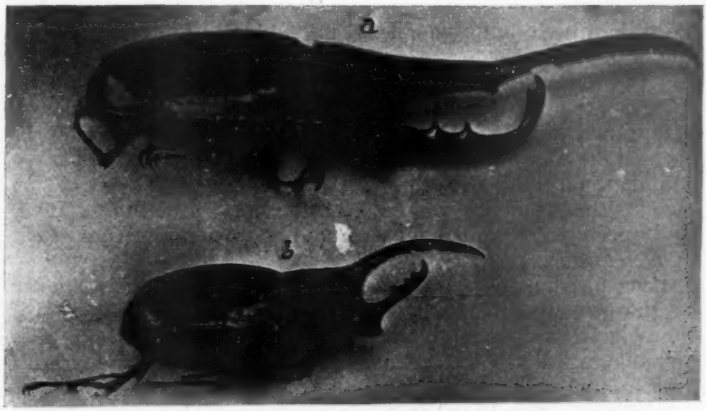


FIGURE 2, *a*. *Dynastes Hercules*. Male, $\frac{2}{3}$ nat. size.
FIGURE 2, *b*. *Dynastes Vulcan*. Male, $\frac{2}{3}$ nat. size. Type, phot. A. H. V.

Habitat.—Interior mountain ranges of Dominica I., from 2000 to 4000 feet above sea level. Several specimens.

To make this notice more complete, the description of a third rare species is here reproduced. It was originally described in a brochure published by A. H. Verrill at Rosseau, Dominica, April, 1905.*

Dynastes vulcan A. H. Verrill. Figure 2, *b*.

Male.—Much smaller and with much shorter and more slender thoracic and occipital processes than even the smallest and most undeveloped specimens of *Dynastes Hercules*.

* *Description of a new species of Dynastes (Hercules Beetle) from Dominica.* By A. Hyatt Verrill.

The thoracic "horn" is much more curved and has the two lateral projections much nearer base than in *D. Hercules*. Occipital horn slender near base but wide vertically from a point near middle to near the anterior end; compressed laterally, broad in profile, but slender when viewed anteriorly, in marked contrast to the occipital appendage of *D. Hercules*, in which species the occipital "horn" is fully as wide anteriorly as laterally, and nearly circular in section.

Protuberances on occipital appendage three in number and of almost equal size and equally spaced between anterior extremity and middle of the "horn." No indication of a bifurcated tip to the occipital appendage, as is usually the case with *D. Hercules*. Anterior profile outline of occipital process almost straight, not convex as in *D. Hercules*. Thorax broader, more depressed, and less conical in dorsal outline than in *Hercules*. Elytra broader, more obtuse posteriorly, and more convex in profile than in *D. Hercules*. Color of elytra uniform, dark, sooty-brown, occasionally with indications of circular or lunate markings of a lighter, more yellowish shade. Lower parts lighter and more brownish than in *Hercules*, with more abundant and lighter colored hair; especially on ventral surface of the head and thorax. Dorsal portion of thorax, especially posteriorly, much rougher and more deeply pitted than in *D. Hercules*.

Length, from anterior extremity to tip of abdomen, exclusive of thoracic appendage, 2·60 to 2·65 inches; dorsal length of thoracic appendage, 1·40 to 1·50; anterior length of occipital appendage, 1·06 to 1·10; width of thorax at posterior segment, 1·15 to 1·20 inches.

Habitat.—Windward or Atlantic slopes of Dominica. Three specimens. Female unknown.

Professor SAMUEL PIERPONT LANGLEY.

In the death of the Secretary of the Smithsonian Institution, America loses its most prominent astronomer and physicist. Professor Langley was born in Roxbury, near Boston, August 22, 1834, and died February 27, 1906. In this interval of over seventy-one years he contributed immensely to the study of the physics of the solar atmosphere and of the earth's atmosphere, besides also taking a prominent part in practical work, such as the distribution of standard time, and development of the aeroplane, considered as a flying machine. His popular writings are distinguished by a beautiful diction, and the pleasure that he took in conversing with young students is proverbial.

After studying at the Boston High School, making a special preparation as architect and civil engineer, and filling temporary positions in the Observatory of Harvard College and the U. S. Naval Academy, he settled, in 1867, as director of the Allegheny Observatory; at the same time the present writer settled at Cincinnati Observatory, and from that to the present the close relationship of the subjects in which we were interested has produced a corresponding personal intimacy. Especially were we for many years first united in the effort to introduce a uniform system of time signals that should be controlled by local observatories, and be a means of support for these institutions in their straightened finances.

While devoting much thought to practical astronomy during 1867–1875, Professor Langley still found time to devote his equatorial to the study of the sun's surface and his drawings of the details of the spots have all the wonderful characteristics of the rarest and best of modern photographs. His attempts to measure the relative temperatures of the spot and the surface, by the thermo-electric method, led to his development of that form of the electric resistance thermometer, which he called the "bolometer." Each form of thermometer has its special troubles, and the bolometer is no exception. For twenty years we have been accustomed to receive pamphlets and memoirs, detailing the steady progress made by himself or his assistants in improving the sensitiveness and accuracy of the bolometer. Notwithstanding the rival apparatus of Ångström and the thermopile, the bolometer is still in favor; of course both instruments must be used side by side if we would attain results better than either one can give alone.

By applying the bolometer to the solar spectrum Langley was able to reach far beyond the limit before recognized and to measure the relative distribution of heat throughout the whole extent of the spectrum; he thus laid the foundation for all modern study of the special absorbing and radiating powers of atmospheres and gases for the individual wave lengths of light.

The last published memoirs by Langley and his assistant, Mr. C. G. Abbot, demonstrate beyond all peradventure the steady decrease of the absorption of the earth's atmosphere as the wave lengths increase.

From the measurement of the distribution of heat in the solar spectrum Langley then passed to the distribution of energy, and from this to the sum-total of energy in the spectrum. Now the sum total of energy was also supposed to be given by Pouillet's or some other form of pyrheliometer, and Langley at once began to experiment with every form or modification of this apparatus. He traveled extensively in this country and Europe in order to consult with all those who were working on these problems, and his progress, up to the end of 1883, was presented in his report on the Mount Whitney expedition, published as Professional Paper Number xv of the Signal Service, under the title, "Researches in Solar Heat." He had already observed from the summit of Mount Etna, and in 1878 from the summit of Pike's Peak, but these new observations were made from the still higher summit of Mount Whitney. In fact the study of the solar atmosphere forced him, first of all modern physicists, to undertake the greatest expense and labor in order to realize even a few days of work at the highest possible altitude. The general result of the expedition to Mount Whitney was to demonstrate that, in all probability, the universal opinion of physicists was in error in believing that the infra-red rays are more absorbed than the luminous and ultra-violet: as Langley himself states, considering the weight of authority against him, he felt bound to repeat his experiments in every manner, and with every precaution. It also followed that the accepted value of the heat radiated from the sun, as received at the outer surface of the earth's atmosphere, must be very greatly increased, and that its value could not be less than 2·6 calories, while it might be as high as 3·5, the most probable figure being 3·0 calories.* We believe that up to the last Professor Langley saw no reason to depart greatly from this result. He made this experience on Mount Whitney a strong argument as to the importance to meteorology of similar observations at other great elevations.

In 1887 Professor Langley was appointed Secretary of the Smithsonian Institution, succeeding Professor S. F. Baird. This necessitated his removal to Washington, where he was able to established the Astro-physical Observatory, and to continue the researches begun in Allegheny. Washington is unfortunate as regards the steadiness of the atmosphere, but its selection was forced upon Langley by circumstances over which

* Namely small calories, or a gram of water heated from 0° Centigrade to 1° Centigrade per square minute per centimeter.

he had no control, and the great work that has been done there will undoubtedly prove an important preliminary experience, leading to the eventual establishment, in a favorable location, and under a competent physicist, of an astro-physical observatory that shall be worthy the name of the founder.

But a very different problem had also fascinated our colleague, namely the soaring flight of the condor, the buzzard, and the sea-gull. While at the Allegheny Observatory he had gathered a collection of aeroplanes and of well mounted birds' wings, had placed them on his whirling machine, and had endeavored to penetrate the secrets of flight. After his settlement at Washington a larger machine and more elaborate experiments were made, in which he was assisted by Mr. George E. Curtis, who had become familiar with the subject through his studies with me of problems treated in my "Meteorological Apparatus and Methods." Professor Langley's work, entitled "Aerodromics" and his incisive article, "The Internal Energy of the Wind," were but the beginning of the new series of studies that occupied his attention up to the beginning of his last illness. A large appropriation was made by Congress for researches and experiments in artificial flight. The best of physicists and mechanics were employed to perfect the powerful little motor. A detailed report on the results has not yet been published, but it is very important that it should be prepared, both in order to save others from the wasteful labor of going over the same ground again, and also in order to secure for America the credit for the great work that was accomplished by him. He was one of the pioneers in this class of work, and like all pioneers prepared the way for the success that we hope ultimately to obtain. A few years ago we spoke of the conquest of space by the railroad, and of time by electricity, or the conquest of the ocean by the steamship, without having the least idea that within the next decade wireless telegraphy and the steam turbine would give us a still more complete conquest. It is so also with the air; we now have the balloon, the aeroplane and the kite, but eventually we shall have the flying machine in some practical form.

As administrative officer in charge of the Smithsonian Institution, Langley defended the principle that the secretary should not sacrifice his scientific work to routine office work, but by continuing it should confer the greater honor on the institution.

Personally Professor Langley was of the gentlest and kindest nature. Nothing but the conviction of duty ever drew a harsh word from him. He could be silent and suffer, but not quarrel. His tender care for his mother and his kindly sympathy for the children of his friends (he had none of his own) will ever endear him to the memory of those who knew him best.

CLEVELAND ABBE.

SCIENTIFIC INTELLIGENCE.

I. Chemistry and Physics.

1. *The Determination of Sulphur in Pyrites.*—This important analytical operation has given much trouble to chemists, but there is hardly another process that has received so much study and has produced so much literature as this, so that it would seem that the methods in use must have been perfected in all of their details. Recent investigations by Hintz and Weber show, however, that there is a serious source of error in Lunge's method as applied by many chemists. They find that when barium chloride solution is added slowly to the acidified solution containing ammonium sulphate the amount of barium sulphate obtained is decidedly less than when the reagent is added rapidly. They find that in the first case the barium sulphate contains ammonium sulphate which volatilizes upon ignition and leads to a loss of sulphur. This unexpected result recalls to the reviewer a variety of natural barite from Missouri in which Ludeking and Wheeler (this Journal III, xlii, 495) found 0·2 per cent of ammonium sulphate, a circumstance which shows the tendency of ammonium sulphate to crystallize with barium sulphate. Hintz and Weber give the following directions for determining sulphur in pyrites: Treat 0·5^{g} of pyrites with 10^{cc} of a mixture of 3 parts of nitric acid, 1·42 sp. gr., and 1 part of hydrochloric acid, 1·17 sp. gr., allow the action to go on in the cold at first, and finally complete the decomposition on a boiling water-bath. Then transfer the liquid to a porcelain dish, evaporate to dryness on the water-bath, moisten with 5^{cc} of concentrated hydrochloric acid, and evaporate again. Take up the residue with 1^{cc} of hydrochloric acid, 1·17 sp. gr., and about 100^{cc} of hot water, filter through a small filter and wash the residue at first with cold, finally with hot water. Add to the filtrate, of somewhat more than 150^{cc} volume, while warm, 20^{cc} of 10 per cent ammonia and heat about 15 minutes to about 70°. Filter off the ferric hydroxide precipitate and wash it with hot water until the volume has reached about 450^{cc}. Add a little methyl orange, neutralize with hydrochloric acid and add 1^{cc} of hydrochloric acid, 1·17 sp. gr. in excess. Heat until boiling begins and precipitate with a boiling solution of 24^{cc} of 10 per cent barium chloride diluted to 100^{cc}, adding the reagent at one time as rapidly as possible with vigorous stirring. Rinse the iron precipitate from the filter, dissolve it in as little hydrochloric acid as possible, precipitate warm with ammonia, filter, and wash the precipitate. Heat the filtrate and washings until the greater part of the ammonia has been driven off, acidify slightly with hydrochloric acid, and treat with some barium chloride solution. If any barium sulphate is found here, add it to the main precipitate. Filter the barium sulphate precipitate, washing

at first by three decantations with boiling water, then with boiling water on the filter until the chlorine reaction has disappeared. Dry and weigh it.—*Zeitschr. analyt. Chem.*, xlv, 31. H. L. W.

2. *The Determination of Grape Sugar.*—The present methods for the quantitative determination of glucose are not based upon definite chemical equations; for instance, the amount of cuprous oxide produced by Fehling's method depends upon conditions of concentration, etc. Glassmann has now worked out two modifications of Knapp's method, which appear to depend upon strict stochiometric principles, but only one of these, apparently the most convenient one, will be noticed here. The grape sugar solution is poured into a boiling solution of mercuric cyanide and caustic potash, or a similar alkaline solution of potassium mercuric iodide, when metallic mercury is precipitated according to the following equations:

$$CH_2OH(CHOH)_4CHO + 3Hg(CN)_2 + 6KOH = COOH(CHOH)_4COOH + 4H_2O + 6KCN + 3Hg,$$

and

$$CH_2OH(CHOH)_4CHO + 3HgI_2.2KI + 6KOH = COOH(CHOH)_4COOH + 4H_2O + 8KI + 3Hg.$$

The precipitate is filtered and washed, dissolved by heating with strong nitric acid, and the mercury is determined with a standard thiocyanate solution, with ferric alum as an indicator, according to the method of Rupp and Krauss, which is carried out exactly like Volhardt's volumetric method for silver. A tenth-normal NH_4SCN solution is equivalent to ·003009^g of $C_6H_{12}O_6$. (The author incorrectly gives this value for 1^{ccm} of $\frac{1}{100}$ normal solution.) A number of test analyses carried out with pure grape sugar give very satisfactory results, but no statements are made in regard to substances which interfere with the process.—*Berichte*, xxxix, 503. H. L. W.

3. *The Boiling of the Metals of the Platinum Group.*—Moissan has heated samples of 150^g each of osmium, ruthenium, platinum, palladium, iridium and rhodium, in his electric furnace, and has succeeded in bringing all of them to the point of ebullition and distillation by the use of currents of from 500 to 700 amperes and 110 volts. Fusion took place in one or two minutes, and boiling was reached in less than four minutes. The vapors were condensed upon a copper tube through which a rapid stream of cold water was passed, so that metallic spherules or microscopic crystals, usually in the form of felt, were produced. All of the metals dissolved carbon from the crucible, which they gave up as graphite upon cooling. The most difficult of all the metals to distil is osmium. Palladium is more readily fusible than platinum, but it does not appear to be more readily volatile than platinum and rhodium.—*Comptes Rendus*, cxlii, 189.

H. L. W.

4. *Rapid Preparation of Hydriodic Acid.*—A convenient and rapid method for preparing this acid is described by BODROUX. He divides a certain weight of iodine into two equal parts. To the first barium peroxide is added in the presence of water:

$$BaO_2 + I_2 = BaI_2 + O_2.$$

The remainder of the iodine is then dissolved in the filtered solution, and sulphur dioxide is passed in until decolorization takes place:

$$BaI_2 + I_2 + SO_2 + H_2O = BaSO_4 + 4HI.$$

The acid is then concentrated by distillation, for the reaction with sulphur dioxide does not take place normally in extremely concentrated solutions, so that it is recommended to use about 180^g of water for 100^g of iodine.—*Comptes Rendus*, cxlii, 279.

H. L. W.

5. *The Radio-activity of Polonium.*—MME. CURIE, who has obtained and described polonium as a radio-active element accompanying bismuth in pitchblende, finds that the material may be enriched by fractionally precipitating the oxychloride by means of water, when polonium is concentrated in the first precipitates. Having thus obtained poloniferous oxide of bismuth with an activity 250 times that of uranium, she measured its rate of decay and found that it loses one-half of its activity in 140 days. This corresponds very closely to the rate of decay of Marckwald's "radio-tellurium," so that it may be regarded as certain that the two substances are identical.—*Comptes Rendus*, clxii, 273.

H. L. W.

6. *The Electrochemical Equivalent of Silver.*—The importance of this constant is such that investigators still prosecute investigations to determine it with all possible accuracy. G. VAN DIJK, p. 286, in a very full paper, reviews the results of previous investigators and gives his own. The following table gives the values (corrected) obtained by various physicists:

Mascart	0·011155	Kahle	0·011181
F. and W. Kohlrausch	0·011182	Patterson and Guthe	0·01118
Rayleigh and Sidgwick	0·011176	Pellat and Leduc	0·011189
Pellat and Potier	0·011191	Van Dijk and Kunst	0·011180

Van Dijk devotes considerable space to a discussion of the corrections employed by Richards which led the latter to adopt the value 0·011175, and believes that his own result, $a = 0{\cdot}011180$ is the true electrochemical equivalent of silver.—*Ann. der Physik*, No. 2, 1906, pp. 249-288. J. T.

7. *The Electrolytic Coherer.*—Under the title of asymmetrical action of an alternating current on a polarizable electrode, Dr. GUNDRY discusses the reasons for the action of what is at present probably the most sensitive receiver employed in wireless telegraphy. This receiver consists of a very fine platinum point which forms the anode, in an electrolytic solution, of an E.M.F. of several volts. The current through this electrolytic cell is

greatly increased by the excitation of electric waves. Fessenden, to whom the priority of the discovery of this receiver has been awarded, believes that the action arises from an increase of heat in the immediate neighborhood of the small electrode; this explanation has been found untenable. Later experiments of Rothmund and Lessing show a coherer and not an anticoherer effect when the electrolyte (phosphoric acid and hyperphosphorous acid at higher temperatures), has a negative resistance temperature coefficient. Reich believes that the action results from a depolarizing effect.

The object of Dr. Gundry's paper is to show that in a polarizable electrode, in general, as soon as we pass beyond the stage of initial capacity the alternating current gives rise to an asymmetry which appears as a coherer effect. His experiments were conducted only with mercury electrodes on account of the more definite conditions which can be obtained by their use. One electrode was very small in order that it might be considered unpolarizable, the other more than one thousand times greater. A galvanometer in the alternating circuit showed that the current, before symmetric, was rendered asymmetric by passage through the cell. In other words, there was superposed on the alternating current a direct current, and the production of this direct current involves the existence of an asymmetry in the E.M.F. of the polarization produced by the alternating current. This asymmetry, the author believes, is a natural consequence of the osmotic theory of electromotive force in general and its application to polarization in particular.

For the production of the alternating current the sine inductor of Kohlrausch alternated in use with the Dolezalek alternating current machine made by Siemens and Halske. An upper limit of 5000 alternations per second was obtained. Experiments with a platinum electrode both anodically and cathodically polarized, showed that the magnitude of the direct current value varied at high frequencies much less with the frequency than is the case with the mercury electrode.—*Phil. Mag.*, March, 1906, pp. 329–353. J. T.

8. *Ionization by Röntgen and Cathode Rays.*—This is a study at Würzburg by J. Herweg of various unsolved points in regard to this subject. It is shown that the ionization produced by the X-rays up to a temperature of 400° is independent of the temperature; in other words, the resulting ionization is not accompanied by a rise in temperature. It is also shown that simultaneous ionization of air by a glowing wire and the X-rays results in a simple superposition of both ionizations.

X-rays and also cathode rays produce a diminution of the discharge potential of the *Glimmentladung;* the effect of the rays is dependent upon the volume of gas between the electrodes and the pressure.

A theoretical discussion of the movement of electrons in a combined electrostatic and magnetic field concludes the paper.—*Ann. der Physik*, No. 2, 1906, pp. 333–370. J. T.

9. *Modern Theory of Physical Phenomena;* by AUGUSTO RIGHI. Authorized Translation by AUGUSTUS TROWBRIDGE. New York, 1905. (The Macmillan Co.)

La Théorie Moderne des Phénomenès Physique; par AUGUSTO RIGHI. Traduction libre sur la 2e edition italienne par EUGENE NECULCEA. Editions de "L'Eclairage Electrique."

These two translations bear witness to the richly deserved popularity of Professor Righi's little book. It is without question the best popular exposition that we have of the modern point of view which explains the phenomena of electricity, radio-activity and optics in terms of the electron. The translation is very well done and the book can be recommended unqualifiedly to the general reader who desires to get in a simple and non-technical form the gist of the epoch-making developments of the theory of electrons. L. P. W.

II. GEOLOGY AND MINERALOGY.

1. *Red Beds of Southwestern Colorado and their Correlation;* by WHITMAN CROSS and ERNEST HOWE. Bull. Geol. Soc. Amer., xvi, Dec., 1905, pp. 447–498, pls. 82–85.—This is the most important paper thus far published on the "Red Beds" of the Rocky Mountain region, and should be read in connection with Stanton's paper on the Morrison formation published in "The Journal of Geology," xiii, 1905, pp. 657–669. All of the Red Beds regions, from northeastern Arizona north to central Wyoming and east to the Front Range of Colorado, are reviewed by Dr. Cross. As his conclusions are of the first importance, his "summary" is repeated here in full. It is as follows:

"1. A marked angular unconformity is exhibited near Ouray, Colorado, between a well defined fossiliferous horizon of the Dolores Triassic formation and an extensive section of Paleozoic beds, including the Cutler Permian and the Hermosa Pennsylvanian formations.

"2. The Ouray unconformity is evidence of a stratigraphic break, of as yet unknown importance, in the midst of the Red beds of western Colorado. There are reasons to suppose that this hitherto unrecognized break is widespread and explains many discordant features of various Red bed sections, not only in Colorado, but in the adjacent Plateau province.

"3. The fossiliferous horizon of the Dolores formation, occurring above the unconformity noted, has been traced down the Dolores and San Juan valleys into the Plateau province. The sections of the mountain and plateau districts are comparable in many ways.

"4. A vertebrate fauna, similar to or identical with that of the Dolores formation, has been found at widely separated points in New Mexico, Arizona, Utah, Wyoming, and Colorado, and paleontologists regard it as clearly of upper Triassic characteristics.

"5. Through the stratigraphic correspondence of the Red beds and associated formations in the Rocky Mountain and Plateau provinces and the evidence of the Triassic vertebrate fauna at numerous points, certain correlations are more or less clearly indicated.

"*a.* The Hermosa formation appears to occupy the same stratigraphic position as the Aubrey of Utah and Arizona. Further investigations are necessary, however, to explain certain faunal differences or dissimilarities noted by paleontologists between the formations.

"*b.* The Cutler formation, being older than the Ouray unconformity, is probably of Paleozoic age and corresponds more or less closely to the Permian portions of the stratigraphic sections of the Plateau and Mississippi Valley provinces.

"*c.* The Dolores formation includes diminished equivalents of the Shinarump and Vermilion Cliff formations of the Plateau. The Shinarump may include important divisions not represented in the Dolores.

"*d.* The La Plata formation is seemingly equivalent to the White Cliff sandstone. Its local assumption of red color has led to confusion with the Vermilion Cliff in certain districts and a reference to the Trias. Since the White Cliff sandstone underlies marine Jurassic beds, and the La Plata transgresses the Dolores and all older beds in marked unconformity, the Jurassic age of the lower division of the Gunnison group seems established.

"*e.* The McElmo formation appears to correspond closely to the Morrison and Como beds and the Flaming Gorge group of Powell. It is probable that the marine Jurassic horizon belongs between the La Plata and McElmo formations." C. S.

2. *Annales de Paléontologie;* published under the direction of Marcellin Boule, Professor of Paleontology at the National Museum of Natural History. Paris (Masson and Co.). Vol. I, Pts. I and II, Jan., 1906.—This new serial in quarto form is to appear four times a year, and will have at least 20 signatures and 20 plates. The price outside of Paris is 30 francs a year. The illustrations are heliotypes made directly from the fossils, while interpretations and explanatory drawings are to appear in the text. Each paper is independently paged, so that works of the same nature may be bound together or each may be bound separately; a second pagination appears at the bottom of each page, which is that of the annual volume. The contents of the first part are as follows:

Fossiles de Patagonie. Les attitudes de quelques animaux; par M. Albert Gaudry. Pp. 1-42.

Paléontologie de Madagascar. I. *Fossiles de la côte orientale;* par Marcellin Boule et Armand Thevenin, avec la collaboration de J. Lambert. Pp. 1–17, pls. 1, 2. Describes Upper Cretaceous invertebrates. A new genus of echinoid was described as *Noetlingia* by Lambert, in 1898, and the name is used here, but

unfortunately it has been preoccupied by Hall and Clarke since 1893 for a Russian Ordovician brachiopod: *Part II. Sur quelques gisements nummulitiques de Madagascar;* par Robert Douvillé, pp. 1–8, pl. 1.

Les grands chats des cavernes; par Marcellin Boule. Pp. 1–27, pls. 1–3.

Types du Prodrome de Paléontologie stratigraphique universelle de d' Orbigny. Pp. 1–4, pls. 1, 2 (incomplete).—The original very brief descriptions of d'Orbigny are here republished with short observations by A. Thevenin; no attempt, however, is made to indicate the present name for these fossils. The illustrations are of much value, as they are photographs of the originals. At least five of the species figured are American Paleozoic forms. Remarks on these are reserved until the work is completed. C. S.

3. *Arthrophycus and Dædalus of Burrow Origin, and Preliminary Note on the Nature of Taonurus;* by Clifton J. Sarle. Proc. Rochester Acad. Sci., iv, Feb., 1906, pp. 203–214. —The first article treats of the supposed fucoids usually known as *Arthrophycus.* An elaborate study has been made of a very extensive series of well-preserved specimens found in the Medina sandstones about Rochester, New York. From these researches, the author concludes that these bodies are not organic, but are the burrows of an animal, possibly a polychæte worm. These burrows and packings may be nearly horizontal with the sedimentation or vertically spiral either to the right or left. The generic term *Arthrophycus* is retained for the plumose forms found on the bedding planes, and *Dædalus* for the spiral burrows.

Taonurus treats of very similar burrows known to Americans as *Spirophyton,* and usually regarded as fucoid. These fossils are common in the eastern Hamilton formation and are undoubtedly made in the same general way as are *Arthrophycus* and *Dædalus.* The evidence and deductions on which the author bases these conclusions can not be presented here, and must be read in detail in order to appreciate these by no means simple fossils. C. S.

4. *Echinoderma;* by F. A. Bather. Zool. Rec., xli, Dec., 1905, 96 pp.—This valuable annual record of the literature of Echinoderma, for 1904, continues the high standard set by the author. It lists 103 titles, and notes the contents of these papers in detail.

5. *The Osteology of Champsosaurus Cope;* by Barnum Brown. Mem. Amer. Mus. Nat. Hist., ix, Dec., 1905, pp. 1–26, pls. i–v.—This memoir gives a detailed description of three more or less complete skeletons of the semiaquatic rhynchocephaloid reptile *Champsosaurus* from the lower strata of the lignite above the Ceratops beds of the Laramie, as exposed on Hell Creek, 130 miles northwest of Miles City, Montana. The material has been well worked out, and the memoir is handsomely illustrated by heliotype plates made in Germany.

6. *Maryland Geological Survey, Vol. V, 1905.* WM. BULLOCK CLARK, State Geologist, pp. 656, pls. 35, figs. 55.—The present volume is largely devoted to economic subjects and each of the parts have been issued separately at different times.

The Second Report on Magnetic work in Maryland by L. A. Bauer, now in charge of the magnetic work of the U. S. Coast and Geodetic Survey, forms Part I of the volume. This magnetic survey of Maryland is the most complete of any magnetic survey in the world except that of Holland, the magnetic declination, inclination and force having been determined in every portion of the State. The results have proved of both great practical value and scientific interest. The plate showing the lines of equal magnetic declination indicates their extreme irregularity, a pronounced focus of magnetic disturbance existing 19 miles northwest of Washington, a local variation of 7 degrees occurring within 7 miles. It is stated that a mathematical analysis of the forces producing the disturbances in this locality traces their source to parallel ridges running approximately in a northeast and southwest direction, agreeing with that of the serpentine beds, as mapped by the geologists.

The report also contains among other papers a report on the highways of Maryland and more than 400 pages on the distribution, value and geology of the Maryland coals.

This volume, like the preceding ones of the series, is handsomely printed, illustrated and bound. J. B.

7. *Les Tremblements de Terre. Géographie Séismologique,* par F. DE MONTESSUS DE BALLORE. Préface par A. de Lapparent, pp. 500, pls 3, 89 page maps and figures; Paris, 1905 (Librairie Armand Colin).—The author of this volume has been known for many years as one who has patiently and laboriously collected all available statistics regarding earthquakes over the whole world, and he is one of the small group of men to whom the new science of seismology owes much. In this publication the whole subject of the geographic distribution of earthquakes is clearly and fully discussed. The numerous detailed maps occurring at intervals through the volume show graphically the location and frequency of recorded shocks. The method of representation has been to cover each town or center of seismic disturbance by a black circle, the length of the radius of the circle being proportional to the number of shocks. This method has been substituted in place of graded tints, bounded by curves of seismic frequency, the departure having been made on account of the essentially discontinuous and localized nature of earthquake centra. This has its advantages for the student of seismology, giving greater precision to the graphic representation of the data, but also possesses its disadvantages, especially for the casual reader. The *area* of a black disc impresses the eye rather than the *radius*, giving the impression of a greater concentration of shocks at certain centers than is actually the case. Again, as the time of observation grows longer the number of scattered shocks

in a region will presumably increase and the additional small circles will finally give something of the tinted effect. In addition, in the more sparsely settled districts there is a lack of complete record of small shocks away from the centers of population and a consequent tendency for the larger circles to cluster around the inhabited districts. For these reasons it might have been advantageous to have supplemented the present detailed maps with more comprehensive ones in which curves and tints should bring out the lines and places of greatest seismic disturbance. To a slight extent this has been done. The author reiterates his previous conclusions in regard to the independence of the great majority of shocks from volcanic centers, even in volcanic regions. The data also bring out the poverty of earthquakes over the geologically undisturbed portions of the crust and their association, on the contrary, with great fault zones, lines of folding, regions of great relief and geosynclines. They are evidence, in brief, of the internal forces of the world still at work.

In regard to the more highly inferential portions of the work; the author assumes the truth of the extreme views held chiefly by certain European geologists in regard to former land masses covering the greater portions of the present ocean basins and known as the Africano-Brazilian continent, the North Atlantic continent, etc., and discusses the relation of the earthquake zones to the fragmentation and foundering of these supposed land masses. It need hardly be said that much of this is highly hypothetical and that according to the charts in the back of the volume there was apparently no room for the ocean waters during Mesozoic time. On the whole, however, the volume is a most valuable contribution to that branch of geology which deals with earthquakes. J. B.

8. *The Copper Deposits of the Clifton-Morenci District, Arizona;* by WALDEMAR LINDGREN. U. S. G. S. Professional Paper No. 43. 365 pp., 25 pls., 19 figs. in text.—The Clifton copper district is second only to Bisbee in rank among the copper districts of Arizona, its production for 1903 amounting to 53,400,000 pounds of copper. The present paper is a complete and detailed discussion of the ore deposits of this area and contains, particularly in its discussions of the contact metamorphism shown in the district and of the secondary enrichment of the ores, important contributions to the subject of economic geology.

The underlying rocks of the quadrangle are schists and a granite of pre-Cambrian age. Upon these rest unconformably a series of Paleozoic sediments, of nearly a thousand feet in thickness, composed chiefly of limestones, with some interbedded quartzites and shales. Above this series are found in certain sections several hundred feet of sandstones and shales which have been assigned to the Mesozoic. Intruded into all of these rock types in the form of stocks, dikes, sheets and laccoliths are a series of igneous rocks ranging in type from diorite-porphyries to granite-porphyries. These intrusions probably occurred in early Ter-

tiary time. Immense flows of later Tertiary lavas which lie unconformably upon the earlier rocks are found to the north of the district and in some places extend down into this quadrangle.

No great disturbance of the region occurred until the intrusions of the porphyries, which caused extensive breaking and dislocation of the sedimentary rocks. Subsequently folding must have taken place, and the uplifted area broke into fragments, which gradually settling down, formed the rocks into monoclinal blocks.

The ore deposits of the district are always found within or closely adjacent to the porphyry intrusions and are considered to have an intimate genetic relation with these rocks. They occur in two main forms; either as tabular bodies in strongly metamorphosed beds of limestone or shale, or as veins in fissures which traverse all of the rock types of the district. The intrusions of the porphyry produced in the adjoining limestones and shales important contact-metamorphic action which resulted in the metasomatic development of garnet, epidote, diopside and other silicates, accompanied by pyrite, magnetite, chalcopyrite and sphalerite. The sulphides were not later introductions but contemporaneous in their formation with the other contact minerals. The contact zone received large additions of oxide of iron, silica, sulphur, copper and zinc, which it is believed were given off by the intruded magma and forced through the adjoining sedimentary beds. These deposits when unaltered are everywhere of too low grade for profitable extraction, but have in many places been attacked by oxidizing surface waters and greatly enriched in value. Workable ores of this class are almost wholly oxidized, being made up chiefly of the two carbonates, malachite and azurite.

The vein deposits were formed somewhat later, but probably while the igneous rocks were still hot and giving off mineral-bearing waters which, circulating through the rocks, deposited the ore materials in the fissures, forming normal veins largely of the replacement type. The bulk of these deposits consist of pyrites with a copper content in the ore, usually below one per cent. But descending oxidizing waters have served to enrich these deposits also, forming in them a belt of chalcocite ore varying between 200 and 250 feet in thickness. During the earlier days the rich ores from the oxidized deposits in limestone and shale furnished the major part of the output, but at present the camp is depending chiefly on these large low-grade bodies of chalcocite ore.

W. E. F.

III. Miscellaneous Scientific Intelligence.

1. *A Contribution to the Oceanography of the Pacific*; by James M. Flint. Bull. U. S. National Museum No. 55, pp. 62, pls. 14, 1905. Compiled from data collected by the United States steamer Nero in 1899 while engaged in the survey of a route for a trans-Pacific cable.—The instructions regarding the

survey were to follow as nearly direct lines as practicable from Honolulu to Midway Island, thence to Guam, thence to Luzon, and also from Guam to Japan. Soundings were to be taken on the outward voyage at intervals of ten and two miles alternately, temperatures and nature of bottom being also observed. The return voyage was planned to cross the primary route zigzag at angles of 45°, the sides of the angle to be twenty miles in length: soundings to be taken at the apices of the angles. In this manner an examination was made of a belt of ocean about fourteen miles wide and over 6,000 miles in length, unequalled in thoroughness, so far at least as soundings are concerned, by any survey hitherto made of an ocean tract (p. 2).

Several submarine mountain ranges were encountered, the most noteworthy occurring east of Guam, with peaks rising to a maximum of 689 fathoms below the sea level, and valleys descending to a depth of more than 5000 fathoms. Four soundings below the 5000 fathom line were made in the abyss now known as the "Nero Deep." The deepest, 5269 fathoms, was about seventy-five miles east-southeast from the island of Guam and is the deepest sounding ever recorded, being only sixty-six feet less than six statute miles.

In computing the gradients from station to station serially on the outward voyage only, involving 1,100 soundings, sixty-nine localities only are found where the gradient exceeds 10 per cent. Of these fifty have an incline between 10 and 20 per cent, eleven between 20 and 30 per cent and six between 30 and 40 per cent. The steepest declivity was found on the slopes of the peak southwest of Midway Island, which rises to 82 fathoms beneath the surface of the water. Here there is a change in depth of 1,269 fathoms (7,614 feet) in a horizontal distance of 1·8 sea miles, a gradient of 70 per cent. With the few and localized exceptions, the bed of the Pacific Ocean, as developed by this survey, though rising here and there near to the sea level, and again descending to depths of five to six statute miles, follows easy gradients.

In commenting upon these results attention should first be called to their great value. The first reconnaissance of the ocean basins has already been completed and the results are embodied in the various charts showing the bathymetric contours. What is now most largely needed are detailed cross-sections such as this supplies of the Pacific Ocean and which the necessity of cable laying has fortunately secured. This has given some precision to the knowledge of submarine gradients along this line. That such is lacking in the Challenger and Albatross cross-sections may be seen by noting the distance apart of the stations except in the vicinity of land, and the resulting fact that the gradients given by connecting the stations are in nearly all cases comparatively flat lines, while the islands rise up with gradients in striking contrasts. For this to be true would imply that there were few or no submarine peaks of the same nature as those forming the oceanic islands but falling short of the surface, an assumption to be justly regarded as unwarranted and disproved along the line of the present cross-sections.

An important extension of the present line of work would be a detailed *areal* survey of chosen regions, one sounding being taken for every square mile, in order to determine the more detailed topography and possibly throw light on the question of the origin of the surface, whether from warping, faulting, folding, igneous extrusion or possibly in some cases from previous subaerial erosion. On account of the slowness of sedimentation over the bottoms of the open oceans, it is doubtful if even geological aeons would suffice to mask the significant features of the broader structures. Such a research might throw unexpected light upon such problems as that of the permanence of the continental platforms. The difficulty and expense of the project, however, are such that it could only be undertaken by government enterprise.

J. B.

2. *The Microscopy of Vegetable Foods, with special reference to the Detection of Adulteration and the Diagnosis of Mixtures;* by ANDREW L. WINTON, Ph.D., with the collaboration of Dr. JOSEF MOELLER. Pp. 701, with 589 illustrations. New York, 1906 (John Wiley and Sons).—"Turn about is fair play." Dr. Winton assisted Dr. Moeller in the preparation of a recent edition of the standard work, "Mikroskopie der Nahrungs- und Genussmittel," and now the favor is well returned. The present volume is in part an excellent translation of the German treatise, but it is very much more. It embodies the results of careful investigations by Dr. Winton, in a wide field of research, and is throughout characterized by clear statement.

Dr. Winton is wise in striking the happy mean between a too extensive presentation of the subject and the scanty hints hitherto accessible to students who read only English. Physicians, analysts, and pharmacists will find this work sufficiently detailed to answer the more important questions which are now arising, and where the information falls short, suggestions as to further treatises are given.

In a concise preliminary chapter devoted to the equipment of a laboratory, the subjects of Histology and gross Morphology are succinctly given. With this in hand, the investigator proceeds to consider the products of "Grain," and then to glance at sundry seeds which are among the many impurities. The third part is devoted to Oil-seeds and Oil-cakes, and here one unfamiliar with the subject comes upon some interesting surprises: numerous unlooked-for species are referred to as accidentally mixed with the more common oilseeds of the mills.

Leguminous plants furnish material for an instructive chapter, the range being very wide. Nuts have also a prominent place. To Fruits and Vegetables, the authors have given a large amount of most useful study. Dr. Winton's examination of the "Jam" fruits is especially noteworthy.

In view of this volume, taken especially in conjunction with Dr. Leach's treatise on Food-Inspection, it may be unhesitatingly said that our Boards of Health are now well supplied with excellent counsel in English as to the best methods of investigating

intentional or "accidental" adulterations of foods. Both of the treatises are also desirable additions to the library of every practicing physician. G. L. G.

3. *The Philippine Journal of Science.* Vol. I, No. 1; edited by P. C. FREER. Co-editors; R. P. STRONG and H. D. MCCASKEY. Pp. 115, with 22 figures. Manila, 1906. Bureau of Printing. —For four years past the Bureau of Government Laboratories of the Philippine Islands has been active in research work, having published thirty-six bulletins dealing particularly with subjects in botany and zoology, and also with various tropical diseases. A new Bureau of Science has now been formed by the consolidation with it of the Bureau of Mines, and the *Philippine Journal of Science* has been begun under the editorship of Dr. Paul C. Freer, and with Richard P. Strong and H. D. McCaskey as co-editors, to contain the researches carried on under the auspices, as well as articles by others, in the Philippine Islands or adjacent countries of the Orient, who are carrying on related scientific work. The first number appeared in January, and contains articles by E. B. Copeland on the Water Relations of the Coconut Palm (Cocos nucifera), with introduction by Paul C. Freer; by H. S. Walker on the Coconut and its Relation to the Production of Coconut Oil; by P. G. Woolley on the Occurrence of Schistosoma Japonicum vel Cattoi in the Philippine Islands; and by R. P. Strong on a Study of Some Tropical Ulcerations of the Skin with Reference to their Etiology. Papers on systematic botany and monographs of various families and genera of Philippine plants will appear from time to time as supplements. The subscription price of the Journal is five dollars per year, and the supplements are supplied to regular subscribers without additional charge. This new Journal has a unique sphere and should prove of great value to science.

4. *Guide to the Invertebrates of the Synoptic Collection in the Boston Society of Natural History;* by J. M. ARMS SHELDON. Boston, 1905. (Published by the Society.)—The actual specimens of the fossil and living animals in the synoptic collection of invertebrates in the Museum of the Boston Society of Natural History are accompanied by numerous diagrams and drawings. These figures illustrate not only the microscopic forms but also such anatomical structures, developmental stages, and other features as are deemed of general interest and which are not distinctly shown in the specimens themselves. They are numbered consecutively with the specimens which they accompany, the whole series of 1264 numbers presenting a comprehensive view of the natural history of the invertebrates.

In this book of 505 pages, Mr. Sheldon gives a very interesting description of the important features illustrated by each of these 1264 specimens and drawings. It is in no sense a mere catalogue, however, but a connected account of the salient features in the whole field of invertebrate zoology. With this book in hand one would be able to study to the best possible advantage the collections displayed, for even without the collections the book is entirely readable, interesting, and instructive. W. R. C.

5. *Monograph of the Isopods of North America. Bulletin of the U. S. National Museum, No. 54.* By HARRIET RICHARDSON. 8vo, 727 pp., 740 text cuts. 1905.—This is a complete monographic work on this group of Crustacea. All the genera and species, as well as the larger groups, are well described and nearly all the species are illustrated, most of the drawings having been made by the authoress. Analytical tables are given for the larger genera. The work is a very valuable contribution to American marine zoology. V.

6. *An Account of the Crustacea of Norway.* By G. O. SARS. Bergen. Published by the Bergen Museum.—We have received parts XI and XII of Vol. V of this extensive monograph, including parts of the families Thalestridæ and Diosaccidæ of the Copepoda. Like all the previous parts, it is profusely illustrated by autographic plates drawn by the author, whose skill and industry are truly marvelous. This work is of great importance to American naturalists, for large numbers of the species and genera are found also on the American coast. V.

7 *Birds of the Southern Lesser Antilles.* Proc. Boston Soc. Nat. History, Vol. XXXII, No. 7, pp. 203-312. 1905. By AUSTIN H. CLARK.—This includes a brief general account of the physical conditions of several of the islands, as related to the avifauna, and some facts relating to the recent destruction of many of the birds by hurricanes and volcanic eruptions. It gives a pretty full catalogue of the birds, especially of Barbados, St. Vincent and Grenada, but little is said of those of Dominica. V.

8. *Additions to the Avifauna of Dominica. Notes on species hitherto unrecorded, with descriptions of Three New Species and a list of all Birds now known to occur on the Island;* by A. HYATT VERRILL. Oct., 1905. Published by the author. Rosseau, Dominica.—In this brochure 72 species are added to the fauna of Dominica, making the total number now known 135. The greater number of additions are, of course, migrating species. The new species are *Thalurania belli* (a humming bird); *Buteo rivierei;* and *Setophaga tropica*, a native redstart allied to *S. ruticilla.* This paper forms a useful supplement to that of Mr. Clark, previously noticed. V.

9. *Beiträge zur chemischen Physiologie*, herausgegeben von F. HOFMEISTER. VII. Band. Braunschweig, 1906 (Verlag von F. Vieweg und Sohn).—Of the forty-six communications included in the latest volume of the Beiträge a large number are devoted to studies of enzymes and their activities. A series of papers by Volhard's pupils in Giessen discusses lipolytic reactions, particularly their probable occurrence in the stomach. Special mention may be made of an interesting attempt (by Obermayer and Pick) to study digestive proteolysis by a new method involving a determination of the changes in the refractive power of solutions at various stages of hydrolysis. Several papers (by Becker, Reichel and Spiro) deal with the nature of the action of rennin. The rôle of colloids and their physico-chemical changes in certain biological processes also form subjects of investigation in papers by Meyer, Pauli, Mayr, and Reiss. In the domain of metabolism the fate of aliphatic amino-acids has been investi-

gated by Dr. G. Embden and co-workers, with the important conclusion, among others, that sugar may be formed from alanin in the intermediary nutritive exchanges. Dr. Wiechowsky has published a detailed review and report regarding the probable status of glycocoll in the synthesis of hippuric acid by animal organisms. Some features of growth are considered in a paper by Falta and Noeggerath, indicating their failure to maintain animals in continued health on so-called "artificial" food-mixtures. Babák has found marked differences in the relative size of the intestines of developing animal forms (frogs), this morphogenetic reaction depending on the kinds of foodstuffs furnished during the period of early growth. As may be expected, there is, further, no dearth of papers dealing with the chemical physiology of the proteids. L. B. M.

10. *Life and Matter. An Answer to Haeckel's "Riddle of the Universe";* by SIR OLIVER LODGE. Pp. 175. New York and London, 1905 (G. P. Putnam's Sons).—A discussion of the fundamental topics in philosophy by one trained to exact thinking in physics must necessarily be interesting, and this is markedly true of the little volume before us. The author states that his object is to make the book an antidote against the speculative and distinctive portions of Professor Haeckel's work entitled "Das Welträthsel." Furthermore he desires to confute two prevalent errors, viz: (1). The notion that because material energy is constant in quantity, therefore its transformations and transferences—which admittedly constitute terrestrial activity—are insusceptible to guidance or direct control. (2). The idea that the specific guiding power which we call "life" is one of the forms of material energy; so that, directly it relinquishes its connection with matter other equivalent forms of energy must arise to replace it.

11. *Joseph Leidy Memorial.*—At a meeting held recently in Philadelphia it was resolved to present to the city, for a place upon the City Hall Plaza, a statue of Dr. Joseph Leidy, in recognition of his memorable contributions to the natural sciences. Over one-half of the amount ($10,000) called for has been already subscribed and it is proposed to raise the balance as speedily as possible. Subscriptions may be sent to Edward B. Smith, Treasurer, 511 Chestnut st.

12. *Memorial to Professor Ernest Abbe.*—Contributions are being solicited in this country, as well as abroad, in behalf of the proposed memorial to Professor Ernest Abbe of Jena, whose invaluable work for optics and optical instruments has made his native town famous. This memorial is to take the form of a statue to be placed in Jena between the Volkshaus erected by him and the Zeiss Works.

The Bausch and Lomb Optical Company of Rochester will receive contributions for this important object; in a circular letter dated March 22 they remark that "this is a unique occasion, as Abbe was a unique man, and most of us who know anything at all about him will consider it a privilege to be able to contribute, be it ever so small a sum, to the statue that is to perpetuate his form to posterity."

LANTERN SLIDES.

A. Collection of Lantern Slides for Lectures on Petrology,

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The following collections are now ready:

1. The mode of occurrence of rock-forming minerals, by ordinary light; 50 slides	£3.10.0
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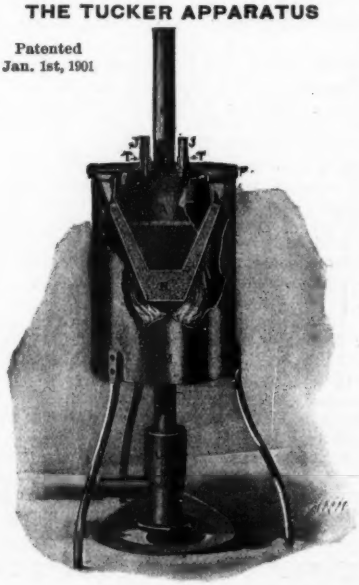

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